Railway Mechanical Engineer

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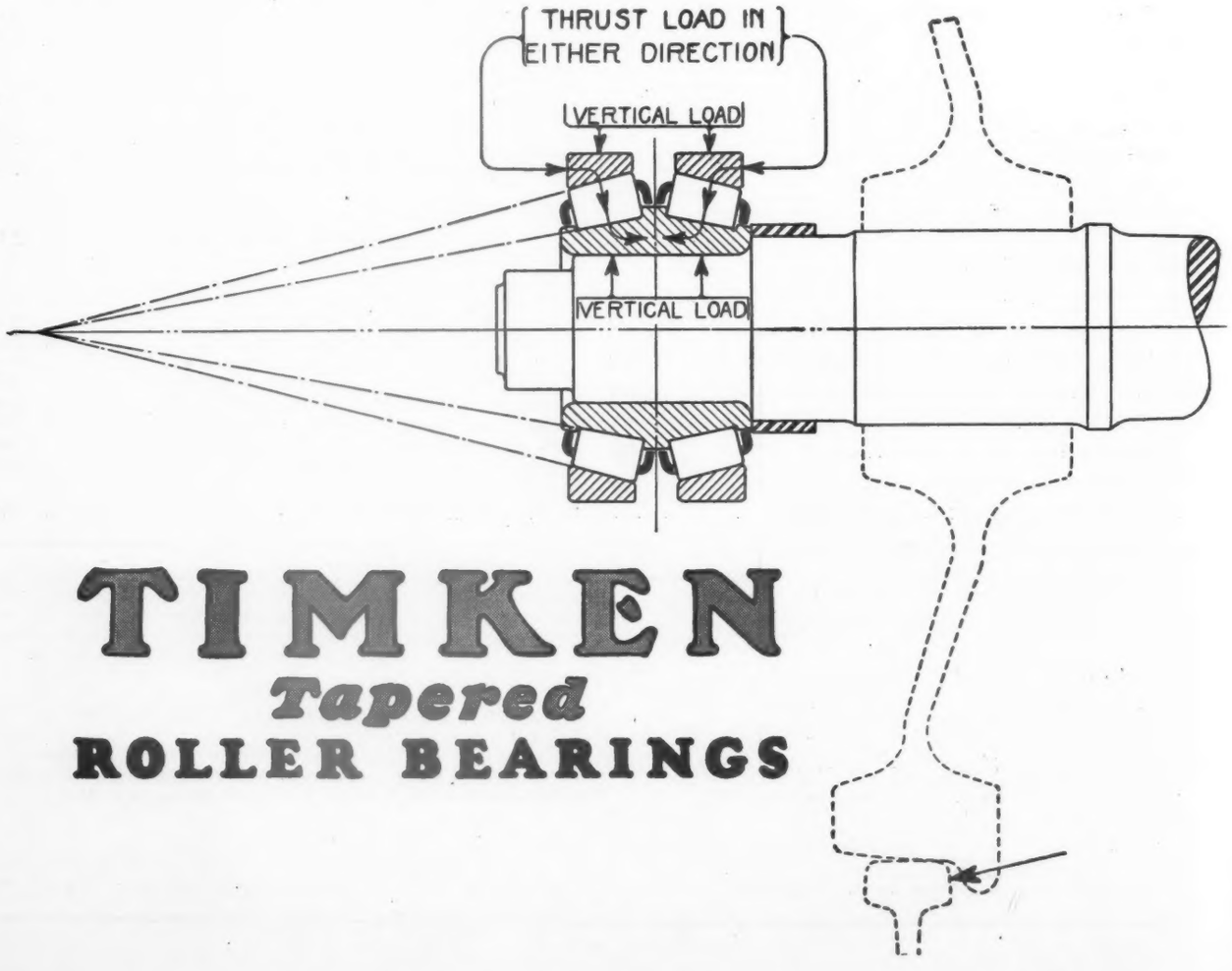

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Railway Mechanical Engineer

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Locomotives stored serviceable

How much reserve power is represented in the 7,490 locomotives reported stored serviceable on Class I railroads at the beginning of the present year? As a result of handling appreciably fewer loaded freight cars per week and obtaining a more intensive use of those locomotives which are in service, many railroads now find themselves in the comfortable position of having more motive power than is needed. Older and less efficient locomotives are, in many cases, repaired, bearing surfaces painted with white lead and stored, being carried on the records as "stored serviceable." These locomotives, representing slightly over 10 per cent of the total locomotives owned, are admittedly a power reserve against future needs but not as much of a reserve as might be considered at first glance. Many of them are greatly inferior to modern motive power, both in capacity and efficiency. To place them back in service at a time of peak traffic movement simply means handling an excessive number of trains on the road at relatively low operating speed, high fuel cost and high train crew expense. As a result of the marked improvement in locomotive design and construction, the modern locomotive has handled up to 80 per cent more ton-miles per hour on 50 per cent of the unit fuel consumption formerly considered good locomotive performance. The old locomotives, therefore, do not represent as great a reserve as their numbers would indicate. From the point of view of economical operation, many of them should never be used in revenue service again.

Delayed railway correspondence

One of the subjects discussed at each monthly staff meeting of the car department of an eastern road is that of delayed correspondence. At each meeting, a member of the staff of the department head is selected to give a talk on the evils incident to the failures to answer correspondence promptly. Certain supervisors fail to realize that letters are written for a specific purpose and not with the idea of bothering the busy foreman on the "firing line." Furthermore, the shop supervisors should realize that most letters, particularly those requesting information, originate with the higher officers, who expect a prompt reply. When follow-up letters are received, they should indicate to the recipient that the writer of the original letter is bringing pressure to bear for prompt action. If a supervisor is requested over the telephone to furnish certain information, he does it promptly, as he feels that it must be important. Letters requiring a reply should be regarded in the same light. Perhaps, an important report, a weighty decision, a question of policy, a matter of expenditure hinges on the information requested in a letter, the answer to which is being neglected. If a letter were received signed by the president of the road, a prompt answer would be forthcoming. If each supervisor would consider each letter received from his superior as important as one received from the president, correspondence then, would receive prompt attention, with the result that it would not be necessary to discuss the problem of delayed correspondence at staff meetings, much annoyance and friction would be avoided and many follow-up letters would not have to be written.

Some questions!

A railroad officer has called upon us to assist him in replying to a letter which he has just received from a railroad man in a Latin-American country. We need a lot of help from our readers if we are to answer the questions fully and adequately. Won't you help us by commenting on the one on which you are best posted? Here is the letter:

"In this far-off, God-forsaken country, argument is truly the only spice of life, so I am writing you to ask if you will be good enough to furnish me with considerable information, to wit:

"Statements have been made that British locomotives are far superior to those of America; that they outlast ours; that they are so perfectly made they will not operate on our so-called inferior roadbeds; that ours are assembled along the lines of a Ford car, give constant trouble and will not steam; that our fireboxes are made of steel to save initial cost, while theirs are of copper; that the fastest trains at present are run in England; that British railroads hold the non-stop records; that American locomotives will not run on British rails, as the beds are too rigid; that the British use 'sleepers' to secure rails to ties, and never spikes as we do.

"That our sleeping cars and Pullmans are inferior to the British and that we crowd more than they do into Pullmans; that the old Mann and Wagner types were far superior to the Pullman.

"That there never has been any change in the basic driving principle of our locomotives; that the present method of air hammer riveting of boilers is far inferior to the old hand method; that the running time between New York and Chicago has been increased several

times, owing to our inferior equipment; that were the line constructed as in England, using their equipment, the run could be made in safety at great speed; that accidents on American roads are 1,000 per cent greater than on British roads and that the same percentage holds true of casualties.

"I fully realize that I have asked for a great deal of your time, but trust you will appreciate what a great service you will be rendering a large host of white men here."

Setting quotas in car department work

Men like competition in work as well as in play. It is not only the spice of trade, but the spice of life. Furthermore, men like to have some definite objective for which to strive. Recognition of these fundamental characteristics of human nature can be and have been made advantageous in railroad work.

Undoubtedly the car department affords a most promising field for the utilization of these characteristics. All mechanical department officers know too well the many difficulties surrrounding the supervision of small car repair and interchange points. They are quite familiar with the tendency of some men to pass up disagreeable tasks or do slip-shod work. Practically all of the methods used by department heads to deal with this problem, may be divided into two classifications; namely, a continual "jacking up" of the men and their foremen by letter and in person, or by setting up conditions under which the men will want to do their work right. The methods pursued by the car department of one eastern road are quite definitely of the latter type.

This car department, which by the way, has made an excellent showing during the past year, has adopted a system of quotas for important items of work. Quotas have been set for the entire system which, in turn, have been divided among the various repair points. Each repair point has a definite quota figure for each item of work it performs, as a mark to shoot at. Each yearly quota is divided into monthly quotas and is based on the amount of work required at each point. Quotas are set for such items as repacking journal boxes. freight and passenger car-miles per hot box, number of freight cars reweighed, freight train detentions due to car defects and cars receiving air brake attention. Competition between repair points, as to material and labor costs per car, amount of overtime and shop output in various class repairs, has been developed and encouraged by the management.

Evidence as to the results that were accomplished in 1927, as compared to 1926, by the use of this method, can be shown by the following figures. Number of repacked journal boxes increased by 50 per cent; freight car miles per hot box increased by 8,000 and passenger car miles by 800,000; freight cars reweighed increased about 45 per cent; reduction in freight train detentions nearly 40 per cent; increase in the number of freight cars receiving air brake attention, about 20 per cent. All this has been acomplished with a reduction in material and labor costs of approximately 15 per cent.

This, in itself, is convincing evidence that this car department management is pursuing the right method. Still there is one thing more that should be mentioned. Competition between the various foremen is keen, but good natured. The monthly staff meetings, at which the actual accomplishment at each repair point is compared with the quota set, are not only educational, but are characterized by good feeling. Good sportsmanship prevails throughout the entire department. Result: every one is trying his best to do a good job and at the same time he is having a lot of fun doing it.

Proportioning modern locomotives

In designing a new locomotive, on what basis may one proceed to proportion the boiler with assurance of meeting the specific requirements as to horsepower capacity? For the past decade the principal reliance in solving such a problem has been in Cole's ratios which were conservatively adequate so long as the proportions of the boiler itself and the relation between the boiler and the cylinders remained within the rather narrow zone of variation, which commonly included the entire range of design practice. Recently, however, designers have departed materially from this zone of proportions both in the design of the boiler itself and in the relation of the boiler to the cylinders and rated tractive force. This is evident in the growing use of four-wheel trailers which support fireboxes with large grate areas. The Type E superheater in itself has completely changed heating surface proportions, the advent of higher boiler pressures and the feedwater heater has materially reduced the evaporation required to produce a horsepower hour. All of these and other changes, each reacting upon the others, have completely changed the numerical values of the basic ratios on which Cole's system of design was built up. C. A. Brandt, in a paper before the Canadian Railway Club, the first installment of which is printed elsewhere in this issue, presents some very interesting and pertinent data bearing on locomotive proportions, in which he calls attention to locomotives which in actual tests have developed as much as 66 per cent more horsepower than the calculated value determined by the use of Cole's ratios. Other locomotives have similarly exceeded Cole's value by from 18 to 29 per cent. Mr. Brandt's paper is worthy of thoughtful study by all who are interested in locomotive design. In the concluding installment, which will appear next month, his discussion of various boiler proportions in detail, in the light of actual test performances should prove highly suggestive as a basis of procedure in developing a revised set of ratios which will more nearly reflect the present-day possibilities of steam locomotive capacity and efficiency.

More about draft gear inspection

While there are serious difficulties which many experienced car department officers feel make it impractical at the present time to require periodical dropping, inspection and repair of freight car draft gears under an interchange rule, there is nothing to prevent individual railroads from undertaking this work on system-owned cars. In fact, a number of roads look with favor on this plan. In one case, a program is being worked on whereby it is anticipated that all of the system cars will have draft gears inspected and faulty conditions remedied within a period of two years. On another road draft gears are removed, inspected and repaired once in three years as cars are sent to shops or repair tracks. A record is kept of the work, the date and station symbols being

stenciled on the sills, and any car which passes the three-year period has its draft gears removed and inspected when next found on a repair or shop track. While this results in a substantial increase in draft gear maintenance cost at first, it is reported that the increase is far more than offset by the reduced cost of repairing other car parts, less damage to lading and fewer road delays. Moreover, the removal of the draft gears gives an opportunity to inspect attachments thoroughly, thus locating and repairing defects which might otherwise escape detection and cause subsequent failure.

In discussing this subject, a correspondent recently emphasized the difficulty of telling much about draft gear conditions without removing the gears and said that it is better to make a real inspection of 100 gears than to make a guesswork inspection of 200 and have them fail in service a month after being inspected. He commented on the need for the work as follows: "A great many cars are leaving shops and repair tracks today with draft gears of an uncertain degree of efficiency and in some cases without any. A conservative estimate of 40 per cent of the total cost to repair freight cars is caused by inefficient draft gears. The sum would represent at least $60 for each freight car, not to mention the millions of dollars spent on damaged lading and the necessity of transferring lading caused by damage to cars." Further intensive effort in the improvement of general draft gear conditions is in order and will prove remunerative.

A lesson from another department

On a large Eastern road the potential economies through the proper use of office machines and supplies were considered of sufficient importance to warrant the appointment of a special committee to study the purchases and use of such supplies and equipment. A recent report on the activities of this committee indicates a saving of approximately $25,000 annually. The report states that the use of certain modern office machines produce annual savings of about 60 per cent on the investment. The report also includes this significant paragraph: "The committee has compiled valuable data respecting the operation and use of different kinds of office machines . . . An accurate card record of each individual machine is maintained showing the date of purchase, cost, description and other details, as well as the cost of repairs made from time to time. Departmental officers are authorized to have office machines repaired locally if the cost does not exceed $5.00 on any machine. Where the cost of repairs will exceed this amount the approval of the committee is required and in such cases the secretary obtains an estimate of the cost and recommends either that the repairs be authorized or that the machine be replaced . . . This plan avoids wasteful repairs to old or obsolete machines and enables the committee to determine which makes of machines can be maintained most economically."

To a mechanical department officer the subject of office machines is of such insignificance as not to warrant much attention. The above mention of the special committee and its findings in relation to office machines, however, contains such a forceful lesson for the mechanical officer that we cannot afford to pass it by. Here, for example, is a railroad that considers office machines important enough to be watched over by a special committee. What, then, may be said of the importance of the machinery used in locomotive and car shops? Here the investment amounts to several hundred per cent more than in those office machines and yet on many roads machine tools seem to be purchased without any systematic methods, retained in service long after they can be efficiently operated and in many cases large expenditures are made for repairs when an investigation of the individual machine would show conclusively that economies would result if a new machine were purchased.

Some of the more progressive roads have found that it is well worth while to keep an accurate record of every machine tool in service, showing the date of purchase, cost, description and, of still greater importance, the cost of repairs made from time to time. Too many mechanical officers seem to overlook the fact that the real cost of a machine tool is not only its initial cost but is actually its initial cost plus the cost of maintaining the machine in service. A high grade machine may cost more to purchase but as a rule will run longer with fewer repairs than an inferior tool. It is only through an accurate record of individual machines that the real cost of a machine may be determined. After a certain number of years of service, depending on types and operating conditions, any machine tool reaches the end of its economic service life beyond which continuance in service can only represent a loss. The service record of a machine is the only means by which one may know when it has reached the point when it should be replaced by a new machine.

When tangible savings can be made by special attention to such small items as office machines can we longer afford to ignore the more substantial economies possible through the adoption of a similarly progressive attitude toward replacing shop machinery?

New Books

CHARACTERISTICS OF SOME ANTI-KNOCK FUELS IN INTERNAL COMBUSTION ENGINES. *By M. K. Thornton, Jr., and Ray Flagg. 28 pages, 6 in. by 8¼ in. Paper bound. Published by the Texas Engineering Experiment Station of the Agricultural and Mechanical College of Texas, College Station, Tex.*

This is bulletin No. 34 issued by the Texas Engineering Experiment Station of the Agricultural and Mechanical College of Texas and is the report of an investigation undertaken to determine to what extent the various anti-knock fuels for gasoline engines exhibit the characteristics claimed for them, especially when used in an engine of a Ford or similar type. Tests were made on two different solutions of nitro-aromatic hydrocarbons, a solution of lead tetra ethyl and on two gasolines containing large quantities of cracked hydrocarbon. The tests show that for engines of the Ford type, equipped with the Ford standard Kingston carburator, and engines of similar characteristics, the use of dopes and fuels contribute materially to the smoothness and satisfaction of operation, but that at any material increase in the cost of the fuel, their use would not be justified.

Improvements in the air brake*

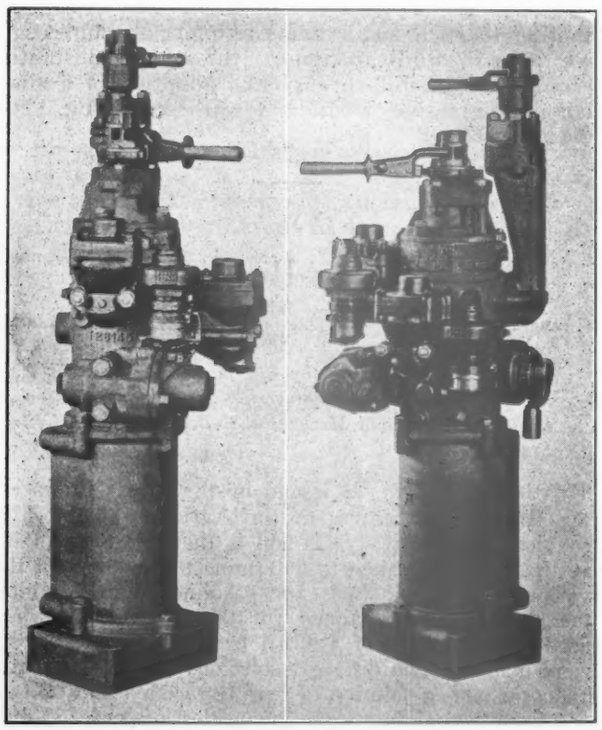
Better railroad operation has required improved air brake performance—One million dollars spent annually on development work

By C. C. Farmer

Director of engineering, Westinghouse Air Brake Company, Wilmerding, Pa.

THAT very substantial progress has been made by the railroads is susceptible of ready proof. Thus, taking 1913 as a basis, freight traffic in 1926 had increased 49 per cent. The loaded car miles had increased but 25 per cent, indicating the effect of increased loading per car. The empty car miles had increased 62 per cent, which is of particular interest in showing how augmented traffic has been handled by better utilization of existing car equipment. The number of freight cars in service in 1913, as compared with the number in service in 1925, offers no marked contrast, as in 1925 the number had increased less than three per cent. But the average capacity of freight cars had increased from 38 tons to 45 tons or 18.4 per cent.

More recent figures are of even greater interest. Comparing the first eight months of 1927 with the first eight months of 1923, the freight car miles per day increased from 27.4 to 30.0 or 9 per cent, the net tons per freight train from 716 to 778, or 9 per cent, the average freight train speed from 10.8 miles per hour to 12.3 or 14 per cent, and the gross freight ton-miles per train hour from 16,464 to 21,768 or 32 per cent.



HJ-2 brake valve mounted on a pedestal to eliminate brake piping in the cab

This brief review of some statistical facts demonstrates, in freight service, an increase in car weight both empty and loaded; an increase in the average car load; an increase in the number of cars per train; an increase in the average speed of the train; and an increase in the daily mileage per car. All of these facts make evident a more intensive utilization of existing railroad equipment facilities.

Obviously the performance of the air brake has had to be improved in order that it might contribute its proper share to the general improvement in railroad operation. It is believed that the developments hereafter described will give evidence that this need has been recognized and met. This development work has been carried on by the Westinghouse Air Brake Company through a specialized engineering organization numbering about 275 persons and at a cost, in the development of new and improved apparatus, well on to $1,000,000 each year. Not only have new complete equipments been produced, but also much work has been done in the improvement of existing devices. Although a change in an existing device is less noted than the production of an entirely new device, yet while difficult to evaluate in dollars and cents, the savings accruing to the railroads in the way of reduced maintenance expense and improved functioning is exceedingly great.

Steam locomotive brakes

The first requisite for an air brake system is a suitable supply of compressed air under the proper pressure and satisfactorily freed of moisture and foreign matter. The cross-compound type of air compressor, now almost a universal standard, has proved by its record, its adaptability to general service requirements. The infrequency of break-downs in actual service suggests that there is no great possibility for improvement in this respect. However, the compressor has been changed to meet various conditions which have arisen on account of newer steam supply conditions. In addition improvements in detail parts have been effected which increase the service life and reduce maintenance cost.

The original cross-compound compressor was intended for a steam pressure of from 200 lb. to 225 lb. Later, conditions were encountered where, especially with passenger trains, such a steam pressure was not always maintained with the result that the air compressor did not in every instance maintain sufficient air pressure. To meet this situation, a compound compressor was provided which operates at its normal capacity on 160 lb. steam pressure. At the other extreme, recent locomotives have included steam pressures up to 400 lb. and it is thought that steam pressures much higher than 225 lb. may be more generally employed. To meet the need for a compressor suitable for higher steam pressures, a compressor of the cross-compound type suitable for steam pressures up to 450 lb. is under development. When it is completed, compressors will be avail-

* Abstract of a paper presented before the Western Railway Club, Chicago, January 16, 1928.

able for any steam pressure anticipated in either regular or special service.

The general introduction of superheated locomotives and especially the somewhat special application of superheated steam for operation of the air compressor, called for a compressor governor capable of withstanding the high temperatures attendant upon the use of superheat. To meet such a need, the material and detail construction of the present standard governor were altered so as to make it suitable for this superheated steam service.

Higher steam pressures employed with some locomotives now in service and planned for others now under design, exceed the limitations of the present standard compressor governor. Therefore, a new governor, suitable for these more exacting conditions, is now being developed.

The possibilities of non-corrosive steels for the manufacture of main reservoirs have not been overlooked, and considerable research has been done in this direction.

The type M feed valve

After the air has left the main reservoir, it is normally reduced in pressure by means of the feed valve before proceeding to the air brake system proper. A noteworthy development has been effected in the new type M feed valve. A characteristic of all older types of feed valves was that, as the brake pipe pressure approached the adjustment of the feed valve, its supply valve partially closed and so restricted and reduced the flow of air. The M type feed valve has incorporated in it a venturi tube, by means of which the supply valve is caused to remain substantially wide open even when the brake pipe pressure is quite close to the feed valve setting. It is, therefore, more effective than the older feed valves in completing the recharge of train brakes and maintaining brake pipe pressure under adverse conditions of leakage. It follows that the use of the type M feed valve has resulted in a marked improvement in the operation of train brakes.

In addition to the improvement just described, the design is such that the interval between cleanings of the type M feed valve has been extended to many times that found practicable with the older forms of feed valves, and the rate and effect of service wear have been greatly reduced, thereby accomplishing a marked reduction in service troubles and a large saving in maintenance cost.

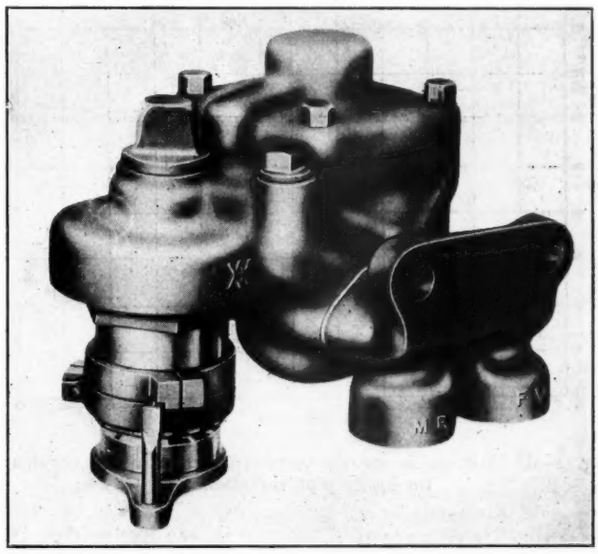
The following figures give some quantitative idea of the degree of the improvement in air supply characteristics. With the type M feed valve, a pressure of 69 lb. is secured on the locomotive of a 100-car train in approximately one minute, whereas with the C-6 feed valve this time becomes 10 minutes or more. Correspondingly, on the one-hundredth car the type M feed valve provides a pressure of 65 lb. in slightly over five minutes as compared with approximately 12 minutes for the C-6 feed valve. Stated somewhat differently, the type M feed valve will maintain 70 lb. pressure at the head end of the train throughout the recharging period, which is a performance not attainable by the older forms of feed valves.

Brake valve pedestal eliminates piping in the cab

To meet requests for means to eliminate cab piping, accomplish a reduction in maintenance expense and a marked improvement in cab appearance, the brake valve pedestal, shown in one of the illustrations, has been produced. This illustration shows the HS-2 brake valve mounted on its pedestal, which provides for location of the two feed valves used with the air brake system and has incorporated in it all other apparatus involved in air brake or train control operation, except the relay brake pipe vent valve which will have a separate mounting in the brake pipe.

The H-6 brake valve pedestal will conform, in general, to that illustrated for the HS-2 except that it will be somewhat smaller because of the lesser number of ports required.

A noteworthy improvement has been made in the functioning of the No. 6 distributing valve. On account of the location of the distributing valve closely adjacent



The Type M feed valve

to the brake valve, where service brake pipe reductions are made, its rate of development of cylinder pressure is somewhat faster than that secured on the cars because the brake pipe pressure at the distributing valve drops more rapidly than farther back in the train.

This development of effective brake cylinder pressure on the engine and tender in advance of the cars causes the slack to close in with a slack shock result varying with the degree of brake pipe reduction, train length, etc., and is followed by a slack jerk when the brakes apply in the rear portion of the train. This is particularly undesirable in passenger service where heavy initial brake pipe reductions are now common with the heavier locomotives and cars and with longer trains, operated at higher speeds and requiring quicker stops.

After considerable experimentation, means were determined by which the service port in the distributing valve could safely be reduced in area so that the rate of cylinder pressure development on the locomotive was held down to a value in substantial agreement to that obtained on the cars in the train.

This improved distributing valve is designated No. 6-E, and has generally been adopted as a standard for new equipment. Also, many of the No. 6 distributing valves in service on the railroads have been converted to the No. 6-E. This improvement has proved to be of decided interest to railroad men because it can be quickly accomplished at a moderate cost and will do much toward reduction of rough handling in passenger service, which is an item of major importance in view of the increasing demand by the public for more smoothly handled passenger trains.

Some years ago vent valves were first introduced on

locomotive tenders, for the purpose of insuring that quick action originated at the enginman's brake valve would pass back to the train under all conditions of double heading, long tenders, etc., and their use has now become general on new equipment. It has provided an increased margin for obtaining quick action throughout

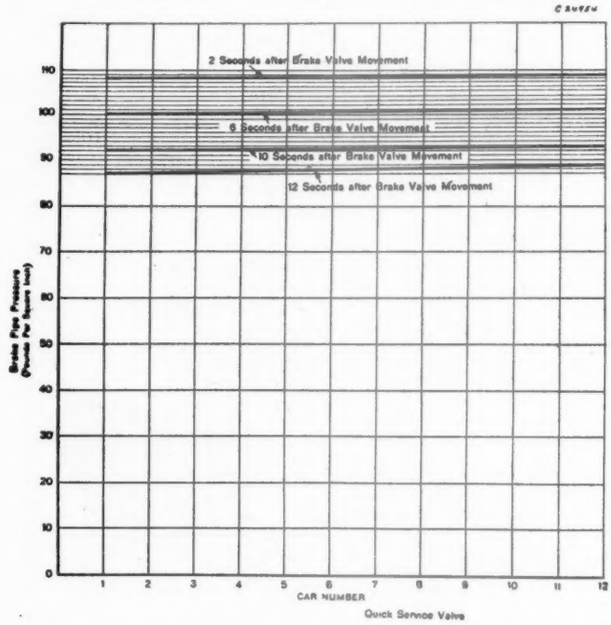

2 Seconds after Brake Valve Movement
9 Seconds after Brake Valve Movement
10 Seconds after Brake Valve Movement
12 Seconds after Brake Valve Movement
Brake Pipe Pressure (Pounds Per Square Inch)
CAR NUMBER
Quick Service Valve

Fig. 1—U-12-B quick service valve—Effect of quick service on brake pipe reduction

the train. It is scarcely necessary to emphasize that it is highly essential that quick action be obtainable whenever wanted.

Passenger car brakes

A development has lately been made in brake equipment for passenger equipment cars that until recently was considered physically impossible. Prior to the World War much time and thought had been given to the subject of improving passenger brake equipment largely in the direction of reducing train slack shocks experienced during the application and release of brakes. At that time it was concluded that the only way to secure uniformly acceptable passenger train stops would be by means of electrically controlled pneumatic brake equipment to produce simultaneous action of all brakes in a train.

This development was interrupted by advent of the war, but was resumed in the postwar period and was somewhat recently brought to completion after finding a way by which the results desired could be obtained by purely pneumatic means. The solution of the problem of incorporating quick service in the universal valve, one of the greatest in importance of recent date, permits securing satisfactory train slack action during service brake operation by the engineman without the exercise of that care and degree of skill formerly necessary but often not exercised on account of local conditions, train schedule requirements, etc. The over-all result is smoother train handling and an important financial saving to the railroads.

With pneumatic brake equipments a passenger car can be operated over the entire United States, and yet complete harmony of brake operation prevail, but if electro-pneumatic brakes had been required to accomplish the improvement, it is obvious that the full advantages of such equipment could not have been realized until all cars were equipped for electro-pneumatic operation.

Problems of interchangeability

American railroads are so accustomed to complete interchangeability of brake equipment that few realize what a difficult situation would be presented if brake equipment were not completely interchangeable insofar as its functioning is concerned.

In Europe a number of brake systems have been applied in different countries, with the result that very frequently cars could not be interchanged, because the brake equipments would not function properly when associated in the same train. This difficulty so interfered with international traffic and the steps to overcome it were so difficult of inauguration that the Treaty of Versailles, which concluded the world war, contained a stipulation whereby the various powers agreed to adopt a braking system by which functional interchangeability could be obtained with their respective car equipment. The fact that it was felt necessary to employ

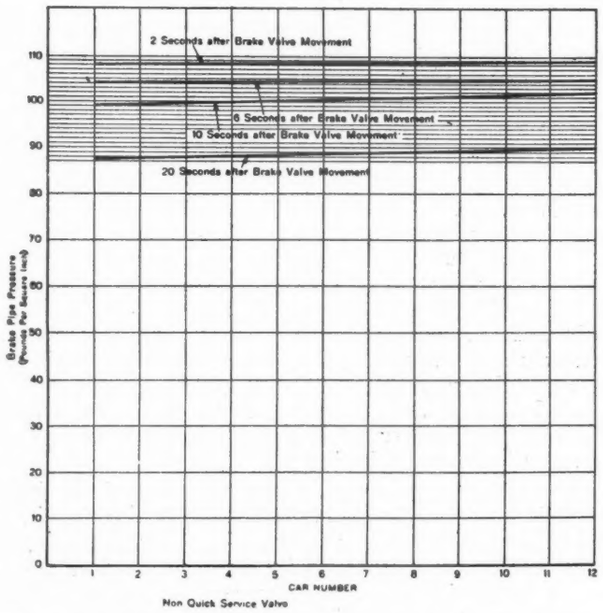

2 Seconds after Brake Valve Movement
9 Seconds after Brake Valve Movement
10 Seconds after Brake Valve Movement
20 Seconds after Brake Valve Movement
Brake Pipe Pressure (Pounds Per Square Inch)
CAR NUMBER
Non Quick Service Valve

Fig. 2—U-12 non-quick service valve—Effect on brake pipe reduction

governmental action to bring about interchangeability in Europe indicates how fortunate American railroads are that interchangeability of all brake equipment has been maintained and in addition that this latest improvement has been accomplished in such a manner as to retain the complete interchangeability heretofore existing, and that again the finished development is in a form which provides improved operation of all of the brakes in any train which includes one or more of the improved brakes.

This noteworthy improvement consists, primarily, of the addition of the quick service feature to the universal valve which is the common standard for passenger equipment cars. The quick service function provides that, when a brake application is being made, each car locally vents brake pipe pressure to the brake cylinder, so that the time of reducing the brake pipe pressure in making service applications is very much shortened over what it is when all the air discharge from the brake pipe has to pass through the engineman's brake valve.

Tests with the UC passenger equipment

The final results of decreasing the time interval between the service application of the brake on the first and last car in a train, as through the operation of the quick service feature, is to decrease the difference in the degree of brake force occurring in the front and rear ends of the train at any time during the application. This, combined with the timing of the engine and tender brake force development must and does result in a more gradual train slack movement and, therefore, smoother train handling. The degree of this accomplishment is well illustrated by the results observed from the operation between Washington, D. C., and New York, of a 19-car train of new Pennsylvania passenger cars, equipped with the improved car brake devices. During this run, which was made primarily to study the effects of roller journal bearings on train starting, stops were made at the most difficult points for stopping and starting, and while the brakes were purposely manipulated in a manner intended to produce rough train slack action and stops, at no time was there slack action developed at any point in the train of sufficient force to permit it to be detected by the most critical passenger.

Perfectly operating brake equipment devices cannot completely compensate for defects in foundation brake rigging which cause non-uniform retarding forces to be developed on different cars in the same train. Therefore, if objectionable slack action is experienced with solid trains of the improved brake equipment devices, the foundation brake rigging should be thoroughly examined. Our experience with a nine-car train operated over this same track, between Washington and New York, while we were making the final road service check of this development, is of interest in this connection. After the universal valves on the cars and ET equipment on the locomotive were in condition to and did apply all the brakes in the times and the rates contemplated in the design, harsh slack action was experienced. A careful investigation of the foundation brake rigging on the cars then disclosed that it was faulty on three cars at the rear. After this was corrected, objectional train slack movement could not be created by any kind or degree of service brake operation with the engineman's brake valve.

Figs. 1 and 2 have been prepared to illustrate the improvement brought about by the inclusion of the quick service function in the universal valve. The curves shown give the brake pipe drop on each car in a 12-car train for certain time intervals. The curves in Fig. 1 pertain to the new universal valve, known as the U-12-B, and the curves in Fig. 2, the old style non-quick service valve, known as the U-12.

It will be observed that the drop in brake pipe pressure for the first two seconds is substantially the same for either valve, but that at the end of six seconds, the quick service valve shows a marked gain. At the end of 10 sec., a 20-lb. reduction has been almost completed with the quick service valve, whereas, roughly, only a 10-lb. reduction has been secured with the non-quick service valve. In 12 seconds better than a 20-lb. reduction has been made with the quick service valve, whereas approximately 20 seconds are required to produce the same reduction with a non-quick service valve. In other words, the time to bring about a 20-lb. reduction through a 12-car train has roughly been cut in half by introduction of the quick service function.

Fig. 3 illustrates the rate of brake cylinder pressure development on the first and twelfth car of a 12-car train and compares two trains, one of which had quick service, whereas the other, in every other way similar did not have quick service. These curves were secured from rack tests and, therefore, are fairly representative of service train conditions.

Considering the non-quick service train, at the end of 9¾ seconds, there are 14 lb. brake cylinder pressure on car No. 1, but on car No. 12 the shoes have just begun to bear against the wheels. This difference in pressure then gradually diminishes but becomes negligible only after an elapse of time greater than that normally required for all closing movement of slack to take place. The conditions at the time of the early high difference in pressure are such as to cause objectionable closing slack movements. In contrast with this, the quick service train shows no substantial difference in brake cylinder pressure at any time between the front and rear. It is in fact not unusual experience that the last car will apply slightly ahead of the first car exactly as shown by the curves. Slack action from inequalities of brake cylinder pressure at any given time must, therefore, be

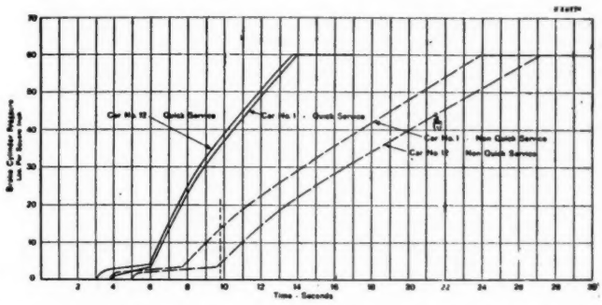


Fig. 3—Chart showing the improvement in emergency transmission time of the UC equipment

practically eliminated so far as chargeable to the action of the air brake devices. From the foregoing, it is obvious that heavy reductions can be made with the train having quick service valves, without producing objectionable shock, whereas, the brake must be applied in steps with the non-quick service valves, in order that the slack may be permitted to close without setting up the excessive difference in speed between the head and the rear, which would result if a heavy straight-way application were made.

While the quick service feature was under development, equal consideration was given the emergency feature which resulted in the speed of quick action transmission also being increased about 100 per cent, thereby reducing the time interval between the beginning of an emergency application on the first and last cars. This will result in shortening emergency stops, and, also through the almost simultaneous action of all brakes, modify, if not almost entirely eliminate, this potential cause for the development of objectionable train slack action during emergency applications.

Freight car brakes

There has been much discussion as to what improvements can and should be made in freight brakes to meet present day conditions and this subject is now being given most thorough investigation and study by the American Railway Association. To facilitate this investigation two major brake developments have been made and two complete and different train sets of equipment furnished. Those who have the opportunity to view and study these equipments and their operation will appreciate the extensive development involved. The accomplishments of these equipments will, no doubt, be disclosed by the American Railway Association later.

A number of years ago the American Railway Association adopted as standard a duplex spring type of retaining valve but purposely left both the closing values and blow down rates for determination later. In due course, we completed laboratory and preliminary road train checks of the different values which seemed practicable and desirable and the association then conducted a series of service trials which later resulted in making standard for the high pressure position a 20-lb. closing value and 90 seconds blow down time from 55 to 25 lb. and for the low pressure position a 10-lb. closing value and 50 seconds blow down time from 45 to 15 lb. Both of these times are longer than formerly used and are very effective in facilitating the control of trains on descending grades, without unbalancing the brake values on different cars in the same train.

Much annoyance and considerable delays have been experienced in recent years by roads having grades requiring the use of retaining valves, on account of the retaining valve springs being stretched by brake cleaners, also on account of repairs to the closing valves and seats being improperly made. This occasioned a request for the development of a structure in which the possibility of damage by workmen would be eliminated insofar as possible. Our study of the problem culminated in the development of the combined cap, valve and spring structure, in which, after the original assembly, the spring valve can not be changed by unauthorized persons or the valve seat be destroyed by grinding. Along with these accomplishments a marked improvement in the uniformity of closing valve action has been secured and the combined betterment should go far toward reducing, if not eliminating, the major retaining valve troubles heretofore encountered on mountain grade railroads.

In connection with brake development for freight equipment cars, empty and load brakes should not be overlooked. Special empty and load equipment has been developed for very heavy cars, such as the 120-ton cars in service on the Virginian or the 100-ton cars in service on the Chesapeake & Ohio. Cars of this class are, of course, not encountered in regular interchange service. Empty and load brake equipment was, however, applied to 2,000, 70-ton cars constructed for the Reading and engaged in coal service on some extremely severe grades. These cars are sometimes offered for general interchange and, therefore, may be found more or less throughout the country. This empty and load equipment, involving a 10-in. empty cylinder and a 10-in. load cylinder, operate in trains otherwise equipped with type K triple valves. Its quick service feature, however, differs from that of the type K in that the local venting is into a quick service bulb and not into the brake cylinder as with the type K equipment.

Apprentice training on the U. P.*

A frank discussion of the underlying principles and philosophy of the plan

By R. H. Beauchamp

Special representative of vice-president of operation, Union Pacific System Lines

EDUCATION for a long time held disdainfully aloof from trade contamination with a tenacity singularly remarkable, and industrial progress was painfully slow. Our progress of the past few years has been markedly rapid, but this was not occasioned by smarter men being born, it came with the putting of overalls on education.

Vocational education is not something mysterious and difficult to comprehend; for to do a thing accurately and efficiently, and understand the purpose and technique, and to learn to properly explain and repeat the performance, is education plus training, which means vocational education. However, it means a little more in the mechanical trades, in that the ability to sketch, make technical computations, and reproduce from sketches is involved.

We have vocational training under many aliases, such as apprentice training, foremanship training, safety first measures, courtesy campaigns, shop councils, round-table discussions, and meetings of various sorts. It is the aim to reach all departments, for there is just as much need for vocational training among the various other industrial occupations as there is with the mechanical trades.

Who is to pay?

The need of industrial education is apparent and recognized, but the big question is: "Who is going to pay for it," Industry has been paying practically the entire cost, but now and then there are indications that workers are becoming conscious of the fact that mental development is principally their responsibility. However, I occasionally hear the plaintive cry that industry gets all the benefits of increased efficiency that workers are able to show through mental and manual training. The greatest wage fixing influence of labor is wholesome intelligence, and the only way in which labor can hope to successfully attain its ends is to properly develop that most powerful influence the world has ever known, the human mind.

Industrial executives should also realize that we are fast approaching the age when the standing of each industry on the industrial chart will be measured, not alone by the intelligence of a few executives, but by the collective intelligence of the entire industrial concern. Honest capital is the victim of ignorant labor, and ignorant labor is the victim of dishonest capital. Industrial education will promote co-operative effort, the fundamental of democracy, and operate to remove ignorance, dishonesty and drudgery. It is the surest road to industrial peace, and both industry and labor are benefited in the same measure.

A democratic procedure

An industrial educational program must have a sympathetic understanding and the sincere interest of those for whom it is intended, yet some do not seem to comprehend the necessity of discarding the cloak of pedagogy and getting on common ground with the worker and industry, in order to build that confidence and faith so necessary to the proper commencement of

*From an address before the American Vocational Education Association at Los Angeles, Cal., December 17, 1927.

educational development. Industrial training is, essentially, a democratic procedure, and must be carried to industry and become an integral part of industry; you can't take industry out of its environment to put it "in school." Furthermore, education must be sold to the worker, and if a demand is to be created, then it must be attractive and profitable.

Some have leaned toward vocational education by correspondence; but to my way of thinking this method with the industrial trades just about approaches zero in educational endeavor. I do not mean to condemn correspondence course as a whole, but I am firm in the belief that insofar as the mechanical trades are concerned, most courses, so far, have proved of little practical value to the apprentice. Furthermore, I am fearful that the reaction in too many instances has seriously retarded industrial education; for subscribers to a vocational correspondence course frequently give up in despair, and having lost faith, they seem to lose spirit.

The classroom work of technical instruction should be in close contact and interwoven with the practical work, and the instructor should have both under his immediate observation, because the apprentice needs guidance while he is doing the work rather than after the work has been done. When a correspondence course is of value, it will, as a rule, prove materially beneficial only to those with advanced education; and most workers do not belong to this class. Therefore, vocational education, being intended for workers with a primary or retarded education, a correspondence course can be of value only when dove-tailed with personal contact by instructors, to see that the ideas are being absorbed and properly understood. We desire that our appprentices have constant contact with instructors and supervisors, so that information will be immediately available, to the end that errors may be avoided and production not retarded.

Every supervisor an educator

Every supervisor should be an educator, and industry is learning that one of the principal requisites of the supervisor is the ability and will to educate and train those under his supervision. No training plan will ever be successful unless it has the sympathetic interest and active co-operation of the supervisor. And to create and secure this interest and co-operation, he must be made to feel that he is not only responsible for discipline of apprentices, but is, in fact, one of the most important members of the teacher faculty. From this statement I believe you will understand why we have been sold to the idea of foremanship training, which I consider the outstanding contribution of federal and state vocational men to industrial education.

In developing our apprentice training plan we readily admit that the little word "economy," which means so much to successful business, was the principal of the composite which influenced our action. We carried the conviction that to train men to our standards and develop their creative and productive powers by teaching the technical side, as well as the practical, and thus build up an organization of efficient men and good citizens, eager to make the most of their attributes and thus command respect and merit promotion, was a big step in the interest of economy; and we have found it so. The men we train develop a sort of ownership feeling toward our company, which has a subtle retaining and stabilizing influence, and now, happily we find that our mechanical labor turnover (labor turnover is the curse of industry and workmen) has been reduced to a reasonable minimum.

A broad influence

Our plan embraces more than education and training. We go so far as to be interested in the social and home life of our boys; but our activities in this respect are so guarded that it may not properly be said that instructors or supervisors assume an unseemly inquisitiveness or meddlesome attitude. Good character is a valuable asset to the man and the institution for which he works, and it is good business to develop high class men. We also encourage thrift.

We do not pretend to be an institution of learning; but an industrial concern that has for its objective safe, efficient, and reliable service. We do not give degrees or awards—except in a manner appropriately fitting we do give a certificate at the end of the journey—but turn out a finished product fully qualified as a journeyman, who will prove a valuable asset to the institution that employs him. It is also our aim to develop honorable, upright, loyal citizens.

We provide well equipped school rooms at all our larger shops, and class room attendance, four hours per week, not to exceed 40 weeks per year, is compulsory. We also encourage attendance at part time classes and special study of subjects in which they appear deficient, and our instructors and supervisors are eager to lend assistance. Materials and supplies, including text data and class room equipment, are furnished by the company. Apprentices must take proper care of the instruments loaned to them.

We have apprentice instructors at all main shops. These are fortified by the valuable assistance and co-operation of the vocational education departments of various states and the federal government, and vocational education departments of some of the city schools. State, federal and municipal representatives also co-operate in vocational extension work with other employees.

Most of our apprentice instructors have gone through college, and have also served time as apprentices. Our requirements are that they be men of good character, so that they may teach character building in the simple way so well understood by the boy, namely, by example. They must be instructors of ability, peculiarly adapted to the work of handling boys; natural leaders. But in addition to the apprentice instructors, each foreman is also a leader and responsible for the boys under his supervision. Questions of boys must never be ignored and their discrepancies must not be overlooked. Cursing or other improper treatment of apprentices is unheard of on the Union Pacific System.

Selection of apprentices

Next to the selection of instructors, is the selection of the apprentices, to which we are now directing special attention. The efficiency of a mechanical product is largely dependent on the quality of the material used; and the same principle applies to the apprentice. Railroad mechanical work is important, and a mechanic should be efficient, accurate and reliable; for the transportation of commodities and human life with safety and dispatch depends on the quality of his product and the accuracy of his work. Therefore, to select a boy who is lazy, careless, unresponsive to responsibility, and physically or otherwise incompetent, is not only a liability insofar as economy is concerned, but his employment would be unjust to the public. We require the equivalent of an eighth grade education as one of the entrance requirements, and the minimum age limit is 17 years.

Favoritism is frowned upon, and, so far as it is pos-

sible to do so, not only the apprentice instructor, the foreman, the master mechanic or the shop superintendent have a hand in the selection and employment of apprentices, but as a follow-up measure I try to find time to have an early personal interview with each new apprentice taken into the service. He is told about many things he can do and of just a few things that will not be tolerated. We tell him that great opportunities may be found in the mechanical field, and that his progress and future achievements depend on his application to work and study as well as on his character, ability and endeavor.

Mental standards

We have a minimum mental standard in accepting applicants, which is determined by written examination and personal interviews. I have little faith in fancy schemes like the so-called intelligence tests, or psychological tests. I do not know much about them, but I do know that when it comes to the creative arts and the handling of men, certain men possess that undefinable something which makes them outstanding. No one knows what that undefinable something is, and no intelligence tests will reveal it; only actual contact with the work and men will indicate to any degree of certainty whether or not a man has it.

Most of our supervisors and instructors would not recognize psychology dressed up in "fancy togs." But whether they realize it or not, all are applied psychologists and teachers (if not, it is a reflection on the management), and as proof outstanding of their ability in these respects, they are selecting and placing boys who are developing into just the sort of men we need; men who learn the technical as well as the practical side of their trades, and who graduate as applied psychologists and tradesmen. And if they show that undefinable something which qualifies them for leaders or specialists, they are assigned to the positions they will best fit in.

Apprentice boards

The boy is taught not to be afraid, but that he must respect his superiors in rank and age. He soon learns we have apprentice boards that keep a careful check of his conduct and his work in the school room, as well as of his practical work in the shop. Each apprentice board is comprised of the master mechanic (or shop superintendent in charge), general foreman and three departmental foremen, and one mechanic each from the seven mechanical crafts. The board must meet at least once every three months, and the master mechanic or the shop superintendent, as the case may be, is the chairman. It is the duty of the board to note the progress of each apprentice, analyze the progress made in the examinations held by apprentice instructors, and examine all other reports that have to do with the deportment, schooling and training of apprentices. It is the duty of the apprentice board to take such action on all matters affecting the apprentice as will reflect a decided interest in their welfare and progress.

The board, by majority vote, may remove an apprentice from the service or change his occupation. In case of a tie vote, the apprentice is given another trial for such period as may be agreed upon by the board, and during the trial period he is paroled to the chairman of the board, who has sole authority as to disposition during that period. It should be understood, however, that authority of the board does not abrogate agreement rules with respect to investigation and right of appeal. Apprentices consider it a severe reflection if called before the board for discipline, and, happily, we are reaching the point where such instances seldom occur. In order to insure the efficiency of the apprentice boards, all details of each meeting must be spread in the minutes, showing the action taken in each case. The minutes are reviewed by the proper mechanical officers, and are held available for inspection by other officers authorized to review this intimately human side of our training plan.

Our apprentice training program does not, therefore, resolve itself into a one-man proposition; every mechanic on the job with whom an apprentice works, and every supervisor on up to the general manager of the property, and up to the vice-president of operation, has an interest and responsibility. Even the president of the company thoroughly understands our plan and takes a personal interest.

We have a definite schedule for practical work in the shop, which may be varied at the discretion of the apprentice instructor. In our school rooms we teach blue print reading, railroad shop drawing, which includes freehand sketching (the importance of which I wish to emphasize), shop arithmetic, and other subjects closely related to actual shop work, such as operation of air equipment, automatic train control and radio. Instruction on the latter subjects, however, is restricted to certain trades and to such details as will prove of practical value to the apprentice.

We are now devising a plan having for its purpose the requirement that each apprentice make a detailed analysis of important jobs, which I much prefer to so-called intelligence tests. We have shop classes on the more important work such as valve setting. Apprentices are sometimes permitted to rebuild freight cars and locomotives as exclusive apprentice productions. We have lectures on safety first, and a definite plan for boys to preside at safety first meetings, shop councils, and other meetings, for which they are frequently required to prepare articles which they know are subject to constructive criticism. We encourage apprentice clubs, but the boys must promote, finance and conduct them on their own responsibility.

We have a system of grading and some standard reports showing characteristics, progress, etc., but I think it is a mistake to burden apprentice instructors or supervisors in this respect. Progressive examinations do not impress me nearly so much as occasional conferences with apprentice boards, supervisors, and instructors, to learn from them their knowledge of each boy in the shop; for if they are able to tell us all we want to know regarding each boy, then we feel there is no occasion for apprehension in respect to the sort of boys we are going to graduate. If progressive examinations will help the boy, then it will be very well to continue them, but if they are intended to tell the supervision something they already should know, they represent time wasted.

Does it pay?

The mechanical trades demand trained men and railroads have always trained men and paid the cost of training. Just now we happen to have the cost localized and it stands out like a "sore thumb." The cost, however, has always been with us, and the objections I hear remind me of the old expense account gag, involving the overcoat which was included but could not be seen. Industrial executives who believe they are getting trained men without paying for the training are either wholly unfamiliar with what takes place, or content with the "covering up" process; that is, they know the cost of training is in the expense account, but are content so

long as lack of exposure does not invite criticism. The difficulty now is that the champions of a prescribed program, who boldly put the "overcoat" in the expense account where it can be seen, are obliged to defend and justify this item of expense; and their chief difficulty lies in the inability to compare a visible expense with a hidden expense.

For example, say we have 1,000 apprentices attending school on company time four hours per day, 40 weeks per year, and the average rate of pay is 50 cents an hour. A few simple computations and we find that the cost of class room attendance is $80,000 per year. Those on the negative side gleefully throw the spotlight on that outstanding figure, and promptly tell you that it is an additional expense, and that the training given is not responsible for the present state of efficiency in shop operations; that tightening up of supervision, speeding up of production, etc., are the responsible factors. This is not an additional expense; it is an exposed expense.

While I do not say that our training program is responsible for every improvement made in the mechanical department, I do say that it has made a healthy contribution to the improvement, and that every venture to improve service is a training process, call it what you may, and industry pays the bill. There are no tangible assets which can be fished out to show that our training program is costing a lesser amount than previously expended, for previous expenditures were hidden. One may support ones argument with generalities, but it takes an unusually clever person to be convincing when dealing with generalities. However, I am firm in my conviction in comparing the results obtained, that we are expending far less to train men than the old method would now cost us. A training plan must pay, for any venture that doesn't pay is a trouble maker.

I do not believe that industry should be required to pay the entire cost of class room attendance. Some think this cost should be on a 50-50 basis; and that would help considerably. I like the 50-50 idea, but I really think that in teaching a man the practical side, safeguarding his person and health, and paying to him a decent wage, is the 50 per cent side of industry, and that a free contribution of time necessary for study and mental development, and a manifestation of willingness and eagerness to render safe and efficient service within reasonable limits of mental and physical endurance, ought to be the 50 per cent side of the worker.

Nickel steel for locomotive boilers*

Possesses high strength and ductility—Physical properties at high temperatures and after ageing superior to carbon steel

By Charles McKnight

Metallurgist, Development and Research department, International Nickel Company

TWO years ago the Canadian Pacific railway in designing some new locomotives desired to increase the capacity and efficiency of their motive power without materially increasing the total weight. This could be done by increasing the boiler pressure 25 per cent but to do that without increasing the thickness of the boiler plate appeared on the face of it to be an impossibility. But the Canadian Pacific successfully accomplished the apparently impossible by taking a step that they had been investigating and considering for some time. This was the use of three per cent nickel steel boiler plate of 70,000 lb. per sq. in. minimum tensile strength. Approximately 30 per cent stronger than carbon steel, its use permitted an increase in boiler pressure from 200 to 250 lb. per sq. in. without any change in thickness of the boiler plate. A total of 44 locomotives were thus constructed for this company in 1926; 24 Pacific type and 20 Mikado type. They have fully justified the expectations of improved performance and efficiency.

Such an unprecedented step on as large a scale as this immediately aroused countrywide interest, not only among railroad officials but among builders and users of other types of boilers. Several railroads have translated this interest into actuality in the shape of one or more locomotives; for example, the new high-pressure locomotives of the Delaware & Hudson have nickel steel boilers. Others are still seriously considering it and experimenting. The same is true of manufacturers of large stationary boilers.

Table I—Average of 523 tests on three per cent nickel steel boiler plate

	Per cent	
	Average	Specified
Carbon	0.163	0.20 max.
Manganese	0.557	0.40-0.80
Phosphorus	0.021	0.045 max.
Sulphur	0.029	0.045 max.
Silicon	0.203	Not spec.
Nickel	2.960	2.75-3.25

	Average	Specified
Ult. tens. str., lb. per sq. in.	77,880	70,000 Min.
Yield point, lb. per sq. in.	47,550	50 per cent U.t.s.
Elongation in 8 in., per cent	26.33	1,600,000, Min. 20 U.t.s.
Red. of area, per cent	54.15	50
Impact value, Izod, ft. lb.	63.4	

Unquestionably the Canadian Pacific railway independently pioneered in this development. It detracts in no way from this road to say that inquiry has since developed that this action was anticipated more than a quarter of a century ago when the Baldwin Locomotive Works built a locomotive with boiler shell, firebox and other important parts of nickel steel. A few years earlier nickel steel plate had been employed for the tubes and boilers of the U. S. cruiser "Chicago." The first stationary boiler of nickel steel was also built about the same time. That these were not followed by more was probably because the demands were not as great then as

* Paper presented before the semi-annual meeting of the American Society for Steel Treating at Montreal, Quebec, February 16-17, 1928.

now and also a better plate was not necessary.

Ascertaining definitely that these boilers had been built so long ago settled quite as definitely the question of what life could be expected of nickel steel. The boilers of the "Chicago" are still in service after 30 years use, although the demands are now light. The same is true of the locomotive, which still operates after more than 25 years of service.

Comparison of nickel and carbon steel plates

During the past two years, beginning with the plates rolled for the Canadian Pacific railway, data have been collected showing the physical characteristics of the low carbon three per cent nickel steel boiler plates. The averages of results of tests on all but a few nickel steel plates which have been utilized during this period for boiler construction are shown in the Table I and compared with a number of tests on carbon steel boiler plate in Table II.

Table II—Average of 385 tests on carbon steel boiler plate

	Average per cent		Average
Carbon	0.193	Ult. tens. str., lb. per sq. in....	59,200
Manganese ..	0.401	Yield point, lb. per sq. in.....	36,200
Phosphorus ..	0.022	Elongation in 8 in., per cent...	28.64
Sulphur	0.033	Reduction of area.....	(Not determined)
		Impact, Izod.....	(Not determined)

Primarily nickel steel is used because of its higher strength with practically the same ductility as carbon steel. But, in addition, the other qualities which are desirable, even necessary, in a boiler are developed with nickel steel to a higher degree than with any other material, so that it is peculiarly, almost uniquely, suited to boiler requirements. These additional qualities are its physical characteristics at high temperatures, its excellent impact values, its resistance to embrittlement in boiler service and its uniformity.

High temperature characteristics of nickel steel

Physical testing of boiler materials at room temperatures and under usual conditions can at best be only an approximate guide to the suitability of the material for boiler service. At best the working temperature of a boiler is some 200 deg. F. higher, in a temperature range where changes occur in the nature of the steel. But even worse, with the temperatures and pressures now being used, the steel enters the "blue-brittle" range, where an ordinarily soft and ductile metal unaccountably loses its toughness and becomes very brittle, although the strength is greater than when cold. A piece of boiler steel which can be bent double when cold will break off short at this temperature and the fracture will have the characteristic blue color which alike indicates the temperature and the derivation of the term "blue-brittleness."[1]

A great deal of research into this matter of high temperature characteristics of steel has been done recently. The data most applicable here seem to be those incorporated in Figs. 1 and 2.[2] [3] The superiority at any temperature of the nickel steel over carbon steel is apparent. In Fig. 1 at 480 deg. F. (corresponding to a saturated steam pressure of about 500 lb. per sq. in. gage) the properties of nickel steel are relatively low. Nevertheless there is a superiority over the special carbon boiler steel of 123 per cent in yield point, 7 per cent in tensile strength, 28 per cent in elongation and 8.5 per cent in impact resistance. The data embodied in this curve are taken directly from the authority quoted and the figures for carbon steel refer to a "special boiler steel" of German manufacture.

Embrittlement in service

The high temperature characteristics of the metal are buttressed by another and unique feature. The boiler designer has always been faced by the specter of embrittlement in service. It has long been known that ordinary tensile tests are of little value as indices of performance in a boiler. Impact tests, resorted to as a means of detecting britttleness prior to service, have failed in their purpose. How misleading such tests can be is shown by the report of Goerens previously referred to. He discusses the phenomena of "ageing" and "recrystallization" of boiler plate in service and then gives interesting data on some full-size long-time tests. The data are too comprehensive and detailed to be included here, but in Fig. 3 are shown graphically the essential results. Briefly, he first annealed a carbon steel boiler plate (0.8 in. by 5.25 ft. by 22.5 ft.) and then

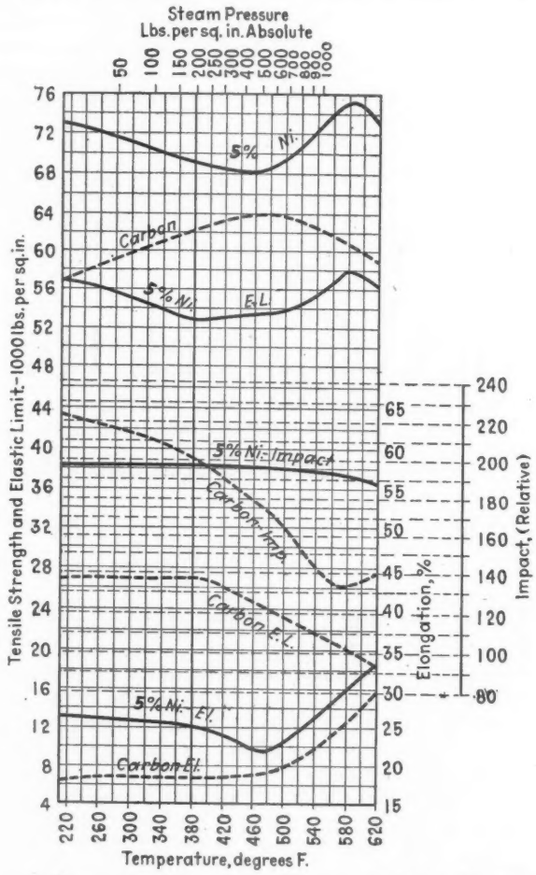


Fig. 1—Characteristics of 5 per cent nickel and straight carbon boiler sheets at elevated temperatures

[1] See "Tensile Properties of Boiler Plate at Elevated Temperatures"—H. J. French—*Transactions*, American Institute of Mining and Metallurgical Engineers, 1922, and discussion thereof.

[2] Data from "Die Kesselbaustoffe," by von P. Goerens, *Zeitschrift des Vereines Deutscher Ingenieures*, Jan. 19, 1924, Vol. 68, No. 3.

[3] The physical data presented in this paper should be considered comparable only in each given set of figures. This is particularly true of elongations and impact values, which vary widely according to the test specimen used.

In examining the results of several thousand tensile determinations, the author encountered discouraging discrepancies, due principally to varying conditions of test. The main factor causing discrepancies seemed to be the finishing temperature of the steel as rolled, which caused surprising variations of results. If this factor is disregarded, it is possible to obtain excellent tensile characteristics from a plate entirely unsuited for fabrication or subsequent service in a boiler.

In the work on nickel steel in our own and associated laboratories, the tensile test specimen was invariably the American Society for Testing Materials standard 8-inch plate specimen and the metal had been given the thermal treatment customary for this type of boiler steel; i.e., a retarded cooling after rolling.

formed it by bending as it would be formed in a boiler. Tested before bending and at intervals of one day, one year, 2½ years without actual service, and 2½ years with 17½ months in actual boiler service, it was found that the strength and elastic limit increased a little progressively while the elongation decreased after bending and then remained practically constant. But most striking is the serious dropping off in impact resistance, from 24.0 to 3.3, a decrease of 86.25 per cent. Small wonder that frequent inexplicable boiler failures occur through embrittlement and cracking.

In a way similar to ageing, recrystallization affects boiler plate but not to so marked a degree. Fortunately,

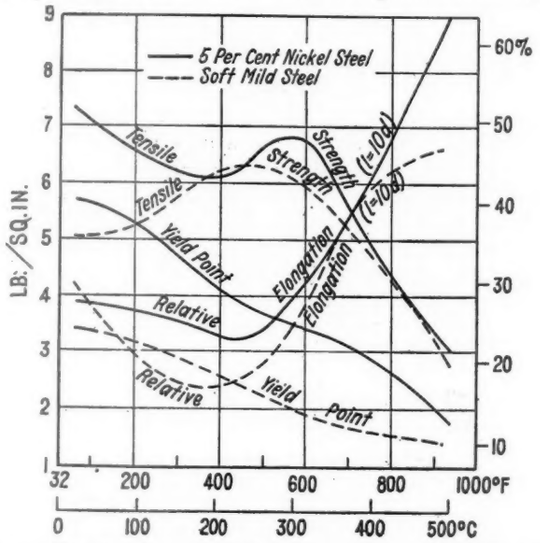


Fig. 2—Tensile characteristics of 5 per cent nickel and straight carbon boiler steels at elevated temperatures

also, the effect of recrystallization is not markedly apparent until temperatures in excess of 900 deg. F. are encountered. Practically, in a boiler the effects of either ageing or recrystallization or both may occur because the plates are stressed during forming and bending in the manufacture of the boiler or they may occur after the boiler is in commission as a result of stresses which are induced by differences in the temperature at various parts of the boiler. The injurious effects will become more noticeable as the boiler pressure and consequent thickness of the plates increase because of the greater difficulties of forming, bending and riveting heavier plate as well as because of the fact that increased heating surface and higher rates of evaporation offer more favorable conditions from temperature differences and additional stresses in the boiler.

Nickel steel resists these two destructive agencies to a marked degree, probably better than any other steel. The results of comparative ageing and recrystallization tests on five per cent nickel steel and "special boiler steel" (carbon 0.11 per cent; manganese 0.53 per cent; phosphorus 0.026 per cent; sulphur 0.031 per cent); are embodied in Fig. 4 which shows conclusively the vast superiority of the nickel steel.

Uniformity of nickel steel

It is well known that there is marked variation both in the chemical composition and tensile results of test pieces taken at various parts of a carbon steel boiler plate[4] and that when specifications are met with tests from one place the plate may diverge dangerously from the requirements at other places. Experience has shown and it has often been commented on that one can confidently expect a much smaller variation with nickel steel. The Tables III and IV show the satisfactory results of several top and bottom tests, as well as the uniformity of analysis.

The valuable bend test has been satisfactorily met. The specifications usually call for a top transverse bend test and, as a general rule, nickel steel not only meets the full requirements of a 180-deg. bend about a pin whose diameter equals the plate thickness, but can be closed down flat on itself without cracking. There is

Table III—Uniformity of tests of nickel steel

Test	Yield point, lb. per sq. in.	Tensile strength, lb. per sq. in.	Elongation, per cent	Area, per cent
Bottom Long.	40,600	77,800	25	56.1
Top Trans.	43,600	76,700	20	36.0
Bottom Long.	41,100	77,900	28	57.0
Top Trans.	42,200	77,700	25	48.9
Bottom Long.	43,500	78,400	25	58.2
Top Trans.	43,100	78,600	25	49.1
Bottom Long.	42,100	77,400	26	59.7
Top Trans.	41,900	78,000	22.5	51.4
Av. Variation, per cent	2.86	2.70	2.37	11.4
Av. Variation, per cent Carbon steel, picked at random, same number	...	6.02	....	...
Analysis:	Carbon	Manganese	Phosphorus	Sulphur	Nickel
Per Cent	0.19	0.55	0.012	0.035	2.95

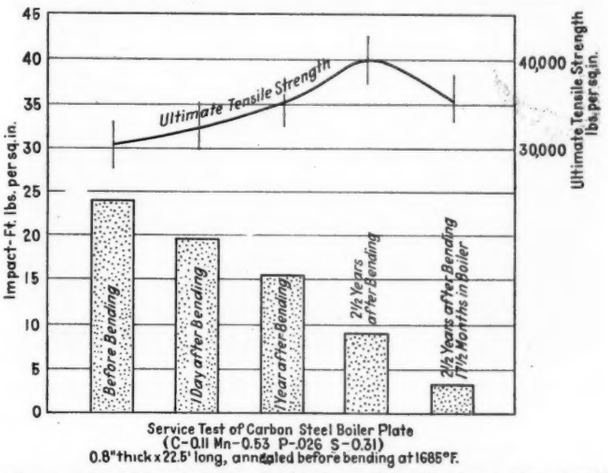

Ultimate Tensile Strength
Impact-Ft. lbs. per sq. in.
Ultimate Tensile Strength lbs. per sq. in.
40,000
30,000
Before Bending
1 Day after Bending
1 Year after Bending
2½ Years after Bending
2½ Years after Bending 7½ Months in Boiler
Service Test of Carbon Steel Boiler Plate
(C-0.11 Mn-0.53 P-.026 S-0.31)
0.8" thick x 22.5' long, annealed before bending at 1685°F.

Fig. 3—Graphic of data obtained on full size long time tests of boiler plate

little difference between the bends on carbon steel and nickel steel. As a matter of fact, one user stated that the bend tests on nickel steel were the best he had ever seen.

Manufacture

In the industrial application of nickel steels, consideration had to be given to the proportion of nickel to be used in the steel. It was eventually decided to use a 2.75 to 3.25 per cent nickel steel. The desirable characteristics of nickel steels are obtained with this steel, although to a slightly less degree than with five per cent nickel. The cost is less and there is the added advantage that such a steel is a standard of which many thousands of tons of plate have been made, the total eclipsing the

Table IV—Uniformity of analysis of nickel steel

	Top, per cent		Bottom, per cent	
Carbon	0.29	0.22	0.21	0.15
Manganese	0.72	0.69	0.73	0.76
Phosphorus	0.018	0.018	0.016	0.016
Sulphur	0.021	0.024	0.027	0.023
Silicon	0.25	0.25	0.23	0.22
Nickel	2.62	2.68	2.66	2.66

[4] See "Experiments on the Segregation of Steel Ingots in Its Relation to Plate Specifications"—C. L. Huston—*Proceedings*, American Society for Testing Materials, Vol. VI

aggregate amount of all other alloy steel plate ever rolled. Table V gives in abbreviated form the physical characteristics which have been obtained in tests of this steel and which are concordant with the results with five per cent nickel steel.

Table V—Properties of three per cent nickel steel

	Tensile tests			Ageing tests		
	68 deg. F.	486 deg. F.	660 deg. F.	Sample	After ageing	After recrystallization
Ult. tens. str., lb. per sq. in.	62,200	64,000	54,100	62,300	66,900	60,000
Elastic limit, lb. per sq. in.	42,700	28,500	25,600	42,700	59,700	38,000
Elongation, per cent	27.5	21.9	33.1	36.0	36.0	33.0
Red. of area, per cent	71.0	63.0	73.1	71.0	67.0	70.0
Impact, ft. lb.	30.6	29.8	28.4	30.1	27.7	29.0

The decision having been made to employ a three per cent nickel steel, there remained only to fit the steel to

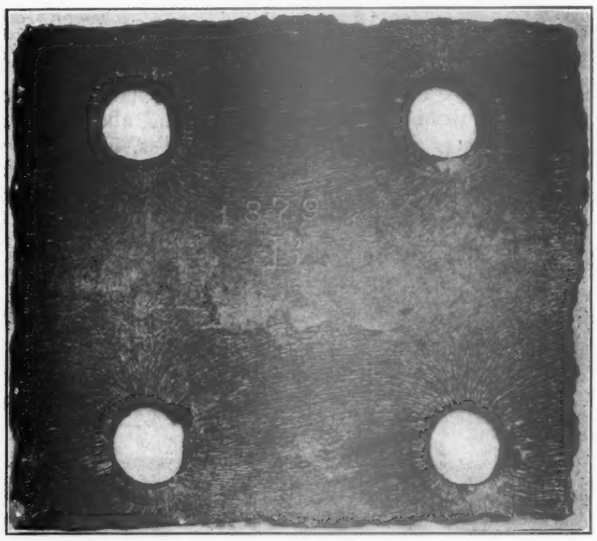


Fig. 5—Carbon steel firebox plate showing corrosion along stress lines

the boiler design. At that time a steel of 70,000 lb. per sq. in. minimum ultimate tensile strength was not only adequate, but generously so. A steel having between 0.15 and 0.20 per cent carbon was, therefore, decided upon and it has not been necessary thus far to depart from that standard.

When the first plates were being rolled, it was mutually agreed by the consumer and the manufacturer that in order to take the most advantage of the contained alloy, the nickel steel should be "killed,[5]" although most boiler plate is not so treated.

With a killed steel, the yield is less than with the ordinary steel, on account of the piped portion of the ingot which must be discarded. A fair figure is 60 per cent or more usable product from the ingot. Also a killed steel is prone to have surface defects, such as "snakes" and "pits."

These variations in practice with killed steels do not detract from their desirability but are, as a matter of fact, guarantees of superior quality. Killed steels for boiler plate have gained a great deal of favor recently and by some it is thought that for high pressure work they will eventually supplant entirely the present type. They have one great advantage in that their defects are usually on the surface and apparent on inspection.

Nickel steel for plate is always killed in modern practice and therefore presents the same problems of yield and surface to the manufacturer. It is essential that the steel be well made, that approved ingot molds and hot-tops be used, that the heating of ingots prior to rolling be given careful attention and that the rolling itself be conducted so as to ensure the best possible surface. With these precautions, experience has shown that there is little difference between nickel steel plate and other killed steels, either in yield or in rejections on account of surface defects.

One of the problems which was encountered and which had to be overcome by the manufacturer was that of unintentional heat treating of the nickel steel. Ordinary boiler plate is finished at the mill in a wide range of temperatures, depending largely on the thickness of the plate, and is straightened immediately after rolling. The continued passing of the plate back and forth between the leveling rolls has almost the same effect as a quench. This does not mean a great deal of difference on the low carbon steels but when nickel steel was so treated, the quick cooling hardened the plates considerably. It was found necessary to roll the plates at a

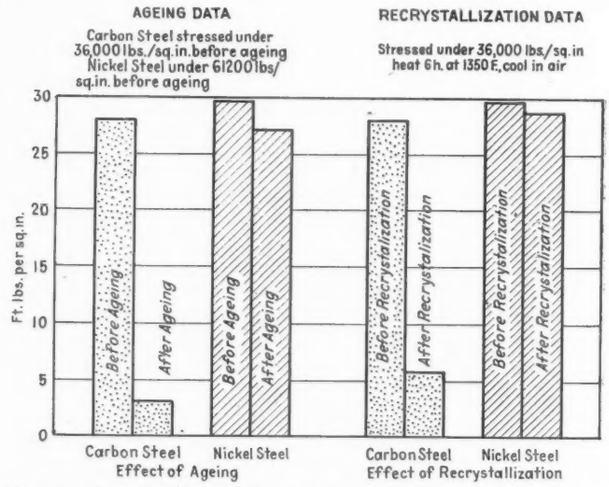


Fig. 4—Comparative ageing and recrystallization tests on 5 per cent nickel steel and special boiler steel (0.11 per cent carbon)

temperature sufficient to ensure their finishing at a good red heat, after which the plates were rolled off the hotbed and piled one on top of the other and later covered with sand. Using this method, it took the plates about eight hours to cool down to a black heat and this anneal, if it can so be termed, resulted in a better product and improved bend tests.

No difficulties in fabricating nickel steel plate have developed and no variation from standard practice has been necessary. Either carbon steel or nickel steel rivets can be used, as dictated by design, and welding with the arc or gas process is perfectly feasible. Nickel steel welding rod should be used.

Possibility of higher strengths with nickel steels

The plates in the boilers of the "Chicago" of 3.5 per cent nickel steel, had an ultimate tensile strength of 80,000 to 90,000 lb. per sq. in., a yield of 50,000 to 63,000 lb. per sq. in. with an elongation in 8 in. of over 20 per cent and they also met with full bend test.[6]

[5] Briefly, a "killed" steel differs from an "open" or "rimming-in" steel in that sufficient silicon, manganese, aluminum or other element is added to render the steel substantially gas-free after solidification. A secondary effect is that, blowholes being no longer present in sufficient volume to counteract it, the steel exhibits piping along the center-line of the ingot. To lessen this, it is essential to use hot-tops and properly designed molds. Silicon is rarely in excess of 0.30 per cent in such steels.

The analysis of nickel steel now being extensively used for boilers was selected not because it was the ultimum obtainable, but because it meets the present requirements of strength adequately with excellent subsidiary characteristics. It now seems possible that the extension of some work already undertaken may make available another nickel steel as much superior to the present nickel steel as it is superior to carbon steel.

Corrosion and firebox cracks

While only a small consideration in the adoption of nickel steel for boilers, a feature not to be overlooked is that of the increased resistance to corrosion. It is, of

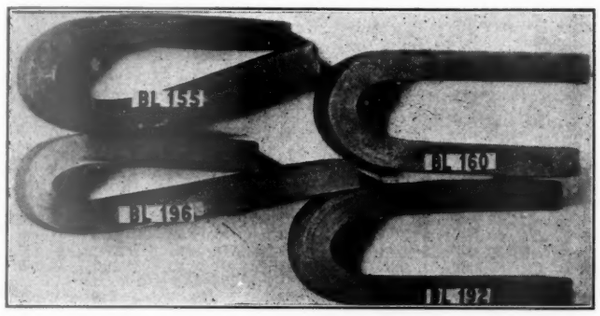


Fig. 6—Bend test on high tensile (100,000-lb.) nickel steel plate

course, well known that above 20 per cent nickel confers practical immunity from the types of corrosion met with in boilers and this immunity is proportional to the nickel content below that figure. With three per cent nickel, tests show a higher resistance to corrosion than the usual boiler materials.

There always has been trouble with firebox sheets of locomotive boilers cracking between the staybolt holes and this trouble is apparently increasing with the increase in the size of boilers and the pressures employed. It is usually considered that this cracking is fundamentally due to corrosion, but we feel that corrosion is of secondary importance. It is recognized that when a steel has been overstressed and then subjected to corrosive agents, the corrosion will take place more rapidly where the stress has occurred.[7] That this condition exists in firebox sheets which crack, seems to be demonstrated by the fact that even a superficial examination will show that the cracks running from one staybolt hole to another take on the appearance of magnetic lines of force (see Fig. 5); i.e. they follow the stress lines. We believe it unusual, if it occurs at all, for these cracks to run longitudinally or parallel with the direction of least strain in a firebox sheet. If these conclusions are justified, then it is not so much a question of corrosion as one of strength and resistance to embrittlement and the obvious remedy is to apply a stronger sheet.

Nickel steel is of double advantage here as its higher strength and resistance to embrittlement enable it to resist the primary cause, while it is also naturally more resistant to corrosion. The first to make practical use of nickel steel for firebox sheets was the Canadian National railroad about three years ago and since then a number of others have made experimental installations. There has been no failure of nickel steel plate from this cause and, on the other hand, in the cases where it has been applied as a cure, it is reported as being effective.

Boiler tubes and staybolts

For boiler tubes the situation regarding corrosion is exactly the reverse of that for shell plate, as corrosion-resistance is here the primary consideration and the increased strength has little to do with it. Boiler tubes running from 0.10 to 0.20 per cent carbon and containing about 2.0 per cent nickel have shown in actual service a life of from seven to fifteen times that of carbon steel tubes in districts where the water is bad. This, of course, has been sufficiently encouraging to warrant the extended use of nickel steel boiler tubes in bad water districts and in addition there are a large number of railroads who either have nickel steel boiler tubes under test or are using them as a regular material on some portions of their line. Their use is not entirely new, as tubes with a higher percentage of nickel were used by several of the navies, among them our own, as long ago as 1900, and ones with a lower percentage only a few years later. The unexplained peculiarity of these tubes has been the fact that boiler scale collects to a much less degree on them than on the ordinary tubes.[8]

Table VI—Corrosion tests

(a) Exposure Corrosion Tests

	Loss in weight, lb. per sq. ft. per year	
	Sea water	Fresh water
Wrought iron	0.1409	0.1275
Soft steel	0.1612	0.1204
Three per cent nickel steel	0.1173	0.1021

(b) Twelve Months' Exposure—Sea Water

	Loss in weight, per cent
Wrought iron	1.89
0.25 per cent carbon steel	1.72
Three per cent nickel steel	1.36

(c) Exposure to Steam and Salt Water

	Loss in weight, per cent	
	Steam two months	Boiling three months 10 per cent NaCl solution
Bessemer steel	0.58	1.81
Open-hearth steel	0.33	1.98
Three per cent nickel steel	0.27	1.00

Results taken from Nickel Steel—Synopsis of Experiment and Opinion—D. B. Browne, *Transactions*, American Institute of Mining and Metallurgical Engineers.

It has been reported in at least one case where a boiler was tubed partly with carbon steel and partly with nickel steel, the nickel steel tubes outlived three sets of carbon steel and when they were removed they were found to be in practically the same condition as when

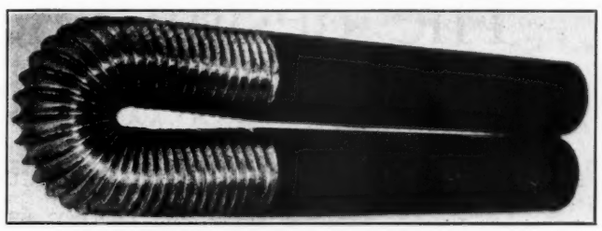


Fig. 7—Nickel steel staybolt threaded bend test

they came from the mill; that is, with the mill scale perfectly apparent.

The primary load on a staybolt is that which it is designed to carry—a pure tensile stress which is not excessive in relation to the strength of the materials used and which is numerically equal to the load due to steam pressure on a square of area equal to the product of the staybolt spacing distances. But a far more important load is that occasioned by expansion of the firebox and

[6] Private Communication, U. S. Navy. Also "Nickeled Steel"—A. L. Colby, *Proceedings*, American Society for Testing Materials, Vol. III, 1903.

[7] See "Risbildungen und Anfressungen an Dampfkesselelementen," Körber and Pomp, *Korrosion und Metallschutz*, May, 1927

[8] "Non-Corrosive Nickel Steel Boiler Tubes"—A. L. Colby—*Proceedings*, Society of Naval Architects and Marine Engineers, Vol. 11, p. 135. Discussion elicited the fact that in a comparative test of two boilers, one tubed with ordinary tubes and the other with three per cent nickel steel tubes, after five months' service the nickel steel tubes were smooth, glossy and free from attached scale, while the ordinary tubes were rough and pitted, with scale covering the pitted surface. An 18 months' trial showed a seven per cent fuel economy in favor of the boiler with nickel steel tubes.

weaving of the boiler. In firing a cold boiler the firebox begins to expand longitudinally before the shell plates are hot, which results in a bending of the staybolts. Eventually, the shell is also heated and expands, so that the bending is to some degree recovered, but this recovery is never entirely complete, since there is always a marked temperature difference between the firebox sheet and the outside shell.

Furthermore, the inside of a boiler where it is in contact with hot gases is very sensitive to temperature changes. For example, the opening of the firebox door will almost instantly cause a contraction of the arch tubes, and to a lesser extent, the boiler tubes. With the closing of the door, expansion re-occurs. This movement is quite marked and has been measured. Any change in position of the inside firebox is relative to the outer shell of the boiler and naturally, therefore, causes bending of the staybolts. In addition, the entire locomotive has a certain amount of vibration.

The result of all these factors is that staybolts are subject to vibration and continual, even if slight, bending motion while under tensile stress, and ideal fatigue conditions are established, which may lead to a failure.

Corrosion is also one of the important factors affecting staybolts. Located in the worst places in a boiler from a viewpoint of corrosion and subjected to stresses and to a temperature difference between the ends, both of which induce chemical corrosion, the staybolt has always been peculiarly subject to rusting and pitting and one of the main considerations influencing the choice of material has been the ability to resist corrosion.

Steel has been replacing other materials used for staybolts quite rapidly and of the various compositions of steel used it is noteworthy that almost all contain nickel in amounts varying from 0.50 to 3.50 per cent. The analysis most often used is a very low carbon 2 per cent nickel steel. For staybolt service such a steel is superior to any other material as it is strong enough for the duty, yet remarkably ductile, has good resistance to fatigue and remarkable impact values. On tests this type of steel has consistently shown impact values of such high order that no other steel is in the same class.

A comparison between staybolt material of wrought iron, steel and nickel steel is shown in Table VII.

Table VII—Comparison of staybolt materials

Material	Carbon	Manganese	Silicon	Nickel	Treatment	Yield point, lb. per sq. in.	Tensile strength, lb. per sq. in.	Elongation	Reduction of area	Brinell hardness No.	Impact	Endurance limit	Stress to cause failure at 15,000 cycles
Wrought iron	0.02	0.04	0.13	...	As received	33,000	49,400	34.0	46.4	103	45	.....	.....
					1650 F. C.	30,300	46,500	36.5	49.3	95	32	.....	43,000
Wrought iron	0.06	0.04	0.09	...	As received	34,000	48,600	34.8	51.2	102	46	31,000	48,000
					1650 F. C.	29,400	45,500	37.3	54.4	92	38	28,000	46,000
Staybolt steel	0.06	0.02	0.01	...	As received	29,900	46,300	41.3	73.3	86	62	28,000	45,000
					1650 F. C.	19,300	49,700	41.0	69.3	88	17	27,000	44,000
Staybolt steel	0.15	0.36	0.03	...	As received	32,250	58,800	39.5	65.2	110	69	30,000	49,000
					1650 F. C.	33,000	53,000	38.3	62.1	101	12	30,000	46,000
Staybolt steel	0.18	0.47	0.07	...	As received	43,500	70,100	32.0	53.7	123	27	.....	.....
					1650 F. C.	34,100	63,800	32.0	51.1	112	9	31,000	49,000
Nickel staybolt steel	0.10	0.07	0.02	2.07	As received	39,600	53,000	41.8	72.7	104	87	.....	.....
					1650 F. C.	41,500	53,700	43.5	79.0	102	87	.....	53,000
Nickel staybolt steel	0.08	0.04	0.02	1.98	As received	40,700	54,900	40.0	76.9	107	82	35,000	.....
					1650 F. C.	42,700	55,100	43.8	77.0	103	83	32,000	51,000

The design and proportion of locomotive boilers*

A decided revision of the accepted standards of locomotive and boiler ratios is needed

By C. A. Brandt
Chief engineer, The Superheater Company, New York

Part I

THE best measure of railroad operating performance today is condensed in the unit, ton-miles per train-hour. There has been a steady increase in the figures expressed in this unit during the past 30 years. No actual ton-miles-per-train-hour figures have been found for the railroads in Canada, but I recollect that for the railroads in the United States, the gross increase was about 42 per cent from 1906 to 1916. From 1916 to 1925 there was an increase of 57 per cent. No doubt the railroads of Canada have equalled or exceeded this record.

The problem that has confronted locomotive designers toward accomplishing this result has been a very difficult one, for increasing the sustained power of a locomotive by direct methods involves an increase in the physical dimensions and the weight on the drivers. The

* Abstract of a paper presented before the Canadian Railway Club, Montreal, Que., February 14, 1928.

weight limitation, with few exceptions, is 60,000 to 65,000 lb. per axle. Determined efforts have been made by some of the larger railroad systems in the country to keep the weight below 62,000 lb. per axle, and thus lessen the destructive action of the driving wheel on the track. Our efforts, then, must be directed toward the production of a locomotive which will develop the highest possible power per unit of total weight, or stating it another way, one that will have as small a weight as possible per horsepower developed. Such a locomotive must, of necessity, have a very high thermal and mechanical efficiency.

There is little hope of increasing the weight on the drivers or of reducing the factor of adhesion below that which has been used on recently designed locomotives. The factor of adhesion usually referred to is the weight on the drivers divided by the maximum tractive force. But we are now recognizing that the true factor of adhesion is the weight on the drivers divided by the maximum turning effort, which may be as high as 30 per cent greater than the average. When the cylinder arrangement is such as to give a nearly uniform turning movement, the true factor of adhesion has been reduced to nearly 3½.

In this paper I shall discuss principally the problems of the boiler and superheater, or the steam-producing part of the locomotive. Usually the boiler problems are discussed independently of the balance of the locomotive. This cannot well be done without some reference to the locomotive in general as the engine and the boiler are so closely related, from the standpoint of construction as well as performance, that one part cannot be easily changed without disturbing its relation to the other.

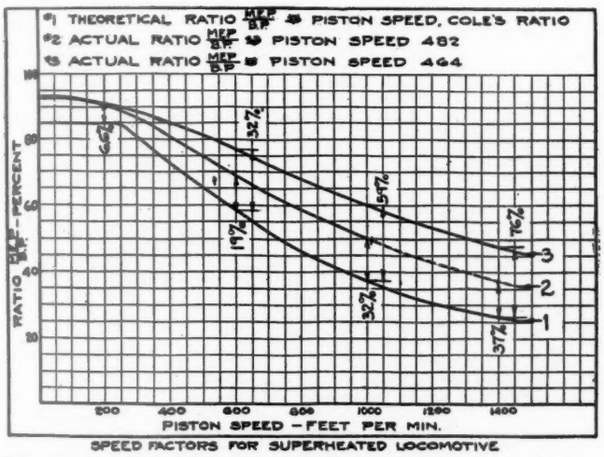

#1 THEORETICAL RATIO MEP/BP PISTON SPEED, COLE'S RATIO
#2 ACTUAL RATIO MEP/BP PISTON SPEED 482
#3 ACTUAL RATIO MEP/BP PISTON SPEED 444
RATIO MEP/BP - PERCENT
PISTON SPEED - FEET PER MIN.
SPEED FACTORS FOR SUPERHEATED LOCOMOTIVE

Fig. 1—A comparison of actual ratios of mean effective pressures with those calculated by Coles Ratios

The design of the boiler and superheater will, in the final analysis, determine not only the efficiency at which the steam is produced but also the efficiency and capacity of the locomotive, since the steam consumption of the cylinders depends largely on the superheat and pressure of the steam. Briefly this relation works out as follows.

The mean effective pressure in the cylinders determines the capacity of the locomotive for all speeds if there is a sufficient amount of highly superheated steam available. The higher the superheat and the initial boiler pressure, the higher the mean effective pressure and the more efficient and powerful the locomotive will be. After the steam leaves the boiler, it must pass through the superheater, throttle and steam pipes. This reduces the steam pressure, due to the frictional resistance of the steam passing through these parts, and it is of the utmost importance that this pressure drop be kept at the minimum.

Here is where the superheater presents a difficult problem, as the steam area through the superheater as well as the superheating surface that can be installed is determined by the diameter of the boiler. Then again, the horsepower capacity can be raised by reducing the back pressure on the pistons. As the vacuum in the smokebox creates the draft which determines the amount of coal that can be burned, it is of the greatest importance that the draft loss through the flues be reduced to a minimum by increasing the gas area through the boiler. This again is determined by the boiler diameter and the superheater. It is thus seen that the diameter of the boiler has a greater importance than any dimension of the boiler design and the greatest possible diameter of boiler should be used in every case.

Of course, there are other factors that affect the mean effective pressure of the cylinders—particularly the valve gear, which determines the valve travel. The importance of long valve travel which produces long port openings at short cutoffs and longer exhaust port openings, has long been recognized. Its use has been incorporated in many recently designed locomotives.

Locomotive ratios

The problems of cylinder and boiler proportion or ratios have been the subject of intense study by many able men, since the first locomotive was built. It would seem to the layman that the laws governing its design should have been all figured out and settled by this time. Such, however, is not the case, and suggestions for improvements are continually being made.

But before we start discussing the design and proportion of the boiler, it is well first to determine what the maximum power is that a given cylinder can develop so we know what to aim at.

Speed factor

The falling off of tractive force of a locomotive as the speed increases is caused by a reduction of the ratio between the mean effective pressure in the cylinders and the boiler pressure. This ratio plotted against piston speed is used to calculate the tractive force at various speeds and is usually termed "speed factor". This factor has been universally used in determining the tractive force and the maximum cylinder horsepower, which was determined some years ago by F. J. Cole, and is plotted as curve No. 1 in Fig. 1.

Developments of the most recent locomotives, however, have shown that it is possible by the use of high superheat and correct proportioning of the boilers and cylinders to raise this ratio considerably. On the same figure have been shown curves No. 2 and No. 3 which illustrate this ratio of speed factor obtained on carefully conducted tests on two recently constructed locomotives.

It will be noticed that a remarkable improvement has been made on these and other similar locomotives and these curves present the best picture that can be painted to illustrate the improvements in locomotive design of today. The speed factor shown in curve No. 2 can safely be used for freight locomotives with wheel diameters up to 70 in. and curve No. 3 for high speed passenger locomotives when a Type E superheater and a feedwater heater is used.

With the above suggestion for determining the maxi-

mum tractive force for starting and at speeds, we can now calculate the maximum cylinder horsepower that can be developed with a locomotive using highly superheated steam.

Steam consumption

The next step is steam consumption per indicated horsepower. In the calculations for the steam demand of a superheated locomotive, a figure of 20.8 lb. per horsepower-hour has been used universally. This was also proposed and used by Mr. Cole and was based on steam around 200 lb. pressure and 200 deg. superheat.

Since the introduction and use of 300 deg. or more the question of the design of the boiler, superheater, feedwater heater, etc. Experience shows that some locomotives are better steamers than others and some are not very good. It is evident, therefore, that there are some features in the design of a poor boiler that impose a limit on the development of higher power or reduce the efficiency as compared with others. Our efforts should, therefore, be directed toward finding out where the weak link is in a particular design and discover the ratios or proportions that would show improvement.

My first intention was to discuss the high pressure water tube firebox boiler only, this being the problem that is today most intensely studied. By high pres-

No	ITEM	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34
1	RAILROAD	P.R.R.	N.Y.C.	C.B.Q.	MO. PAC.	OMAHA	L.I.M.A.	C.B.&N.W.	A.T.&S.F.	P.R.R.	P.R.R.	TEX. PAC.	C.B.&Q.	B.L.W. 60,000	G.T. NOR.	C.B.Q.	D.&R.G.	D.&R.G.	L.V.	N.Y.C.	N.Y.N.H. & H.	CAN. PAC.	ERIE	U.P.	CAN. NAT.	NOR. PAC.	P.R.R.	SANTA FE	CAN. PAC.	N.Y.C.	P.R.R. 17.3.7	N.Y.C.	NORFOLK & WEST.	JULIEN	P.R.R.
2	CLASS OR TYPE	2-8-0	2-8-0 G-5	2-8-2 K-3	2-8-2	2-8-2	A-1	2-8-4	2-10-2	2-1-1-2	2-1-1-2	2-10-4	2-10-4	2-10-2	2-8-2	2-8-2	2-8-2	2-8-2	4-8-2	L-2	4-8-2	4-8-2	2-8-4	4-12-2	4-8-4	4-8-4	4-8-2 K-1	4-8-4	4-6-4	4-6-2 K-2	4-6-4 K-4	4-6-4 J-1	2-8-0	2-8-0	2-8-0 H-8-S
3	YEAR BUILT		1911	1912	1923	1926	1925	1927	1915	1918	1923	1927	1927	1923	1925	1926	1927	1926	1923	1925 1926	1928	1914	1927	1926	1927	1926	1926	1916-17 9-19-28	1926	1911	1913	1927			
4	BOILER PRESSURE (LBS")	205	200	170	200	200	250	240	170	250	250	250	250	350	210	225	240	210	200	225	265	200	250	220	250	210	250	210	250	200	205	230	380	400	205
5	CYL. DIA & STROKE (INCHES)	22"×28	23-1/2"×32	24"×28	2-15"×30 1-13"×30	27"×32	28"×30	27"×32	28"×32	30"×32	30"×32	24"×32	26"×32	HP 15.5" 17"×24"	4-26"×32	27"×32	4-26"×32 4-26"×30	25"×28 1-13"×28	4-27"×32	27"×30	27"×30	25"×32	28"×34	4-27"×34 4-27"×31	25"×30	28"×30	27"×30	30"×30	25"×32	22"×28	27"×28	25"×28	23"×30 41"×20"	32"×30	23"×28
6	DIA. DRIVERS (INCHES)	56	63"	56"	63"	63	63	63	57"	68"	68"	63	64"	63½	63	57"	63"	67	64"	64	69	70	70"	67"	73	73"	72"	73"	75"	74"	80"	79	57	57	62"
7	WEIGHT ON DRIVERS (LBS)	213,200	216,000	244,500	244,500		248,100	253,500	248,900	342,000	352,500	300,000	353,800	338,400	510,000	508,000	559,500	288,000	446,500	344,000	260,000	292,000	375,000	355,000	230,000	260,000	273,500		183,900	173,000	202,800	182,000	298,500	295,000	299,900
8	TOTAL WT. OF ENG. (LBS)	344,200	343,000	372,000	340,000		385,000	377,000	395,900	571,800	586,100	448,000	512,110	457,500	578,000	574,000	649,000	417,000	569,000	564,000	379,000	386,000	448,000	495,000	388,000	416,000	383,000		306,500	271,000	309,140	341,000	348,000	336,500	349,300
9	TRACTIVE POWER (LBS.) (TP= .85 D²S P/W)	42,150	45,800	60,800	65,700	63,000	69,400	75,540	63,500	90,000	90,000	83,000	87,200	81,500	141,000	113,590	131,800	73,308	64,700	60,000	71,000	62,800	70,400	76,630	56,800	57,500	64,500	66,000	45,000	59,100	44,500	45,300	70,300	70,800	49,200
10	BOILER I.D. 1ST COURSE (INCHES)	78½"	80"	81"	86"	84½"	86⅝	86"	79⅝	82½"	82"	86½"	90"	81⅞	100"	92"	100⅝	90⅝	82½	82⅝	74⅝	72"	90"	90"	80⅝	82⅝	82½	86⅜	78½	78⅝	89	82⅝		83⅜	
11	BOILER O.D. LARGE COURSE (IN)	84½	83⅜	96"	92.18	96	94"	96"	91⅝	93"	93"	98"	104"	94"	109	104	110"	104	96	96"	93	80½	100"	105"	90"	94	96"	99⅝	88"	78⅝	89	87⅝			83⅜
12	LENGTH OVER TUBE SHEETS (TH)	13'-9½	18'-0½	19'-0"	19'-0	19'-6	20'-0	20'-0	21'-0"	19'-1	19'-1"	21'-6	21'-6"	23'-0	24'-0	24'-0	24'-0	19'-6"	21'-0"	20'-6	19'-8"	20'-8½	21'-0	22'-0	21'-6	21'-0"	19'-1"	21'-0	18'-0"	21'-5½	19'-1"	20'-6	15'-0	15'-0	15'-1"
13	COMBUSTION CHAMBER LENGTH (IN)	—	—	—	40"	21"	—	—	—	42½	42½	42"	51"	—	72"	74"	72½"	60	52"	51"	—	—	—	80½	48½"	74½	98"	44"	27⅜	—		—			—
14	GRATE AREA (SQ. FT)	49.1	56.5	66.7	66.8	70.3	100	100.3	58.5	70	70	100	108	82.5	108	112.9	136.5	95	84.3	75.3	70.8	59.6	100	108.25	84.3	115	69.9	108.4	66.87	56.5	69.3	85	71.4	82	55.34
15	TUBE & FLUE HEAT. SURF. (SQ.FT)	2677	2766	3740	3437	4010	4782	4460	4175	4044	4486	4643	5445	4420	6705	5982	6548	4586	4337	4047	3633	2716	5251	5260	3615	4133	4302	5129	3005	3533	3729	4211	1413	1904	2840
16	FIREBOX HEATING SURF (SQ.FT)	166	212	311	363	299	341	406	193	290	287	537	445	772	421	467	715	509	392	356	458	316	380	591	437	485	395	541	297	231	307	281	1187	1217	187
17	TOT. EVAP. HEATING SURF (SQ.FT)	2843	2978	4051	3800	4319	5123	4866	4368	4334	4773	5180	5890	5192	7126	6449	7263	5095	4729	4453	4091	3032	5631	5851	4252	4618	4697	5670	3302	3764	4036	4492	2600	3121	3027
18	SUPERHEATER HEAT. SURF (SQ.FT)	—	380	632	1051	1000	1158	1131	831	1479	1820	2100	2487	1357	1920	1801	2160	1511	1249	1985	1756	790	2480	2560	1840	1985	1630	2426	864	700	1172	1985	574	700	600
19	FIREBOX VOLUME (CU. FT.)	122.38	272	404	390	385	465	419	278	364	364	589		683		737	1009	609	543	482			512	898	445	654	516	631		320	427	372			223
20	NET GAS AREA THRU BOILER (SQ.FT)	6.1	7.52	9.34	8.81	9.91	10.6	10.22	9.22	10.1	9.43	9.46	11.1	9.375	13.51	11.85	13.25	11.7	10.0	9.71	8.5	6.46	11.42	11.5	9.16	9.45	9.71	11.05	7.91	6.65	9.13	9.66	6.76	7.43	7.76
21	TYPE OF SUPERHEATER	—	A	A	A	E	E	E	A	A	E	E	E	A	A	A	A	A	A	E	E	A	E	E	E	E	E	E	A	A	A	E	COIL	COIL	A
22	STEAM AREA THRU S.H. SQ.IN.	—	38.73	41	31.3	30.51	31.82	31.92	36.84	34.7	61.5	64.87	78.26	57	77.54	68.4	84.4	72.96	51	63.5	59.93	36.4	78.97	78.17	57.1	64.16	56.1	77.56	45.6	31.89	45.6	64.2	46.2	55.9	41
23	CYLINDER H.P. COLE'S FORMULA	1785	1904	2576	2836	2624	3250	3150	2400			3780	4320	4110	5930	4280	5840	3555	3370	2950	3460	1990	3650	4325	2925	2960	3280	3405	2380	1745	2685	2580			2308
24	MAX. I.H.P. OBTAINED ON TEST	1036			3176		3700			3486	3863	4200		4515					5035	3800				4917			3621				3184	4295			1830
25	MAX. EVAP. CALCULATED (COLE'S)	36295	40410	52968	51840	60665	71341	113904	88000	55386	66121	80613	84310	79390	79600	75610	94638	72410	60360	64643	65153	42575	78864	90376	66008	72135	60241	86174	45794	41500	50070	61776			39787
26	MAX EVAP OBTAINED ON TEST	25896			61680					58301	64656																72520				65408				33955
27	WT ON DRIVERS PER I.H.P. ACTUAL OBTAINED ON TEST (1:24)				77.2		67.2			98.25	91.3	71.5		75.0					81.3	64.3				72.3			75.5				63.75	42.3			12.0
28	TOTAL WT. OF ENG. PER I.H.P. ACTUAL OBTAINED ON TEST (1:24)				10.7		10.4			16.5	10.0	10.68		10.15					12.15	9.58				10.1			10.58				9.71	8.0.			13.6
29	MAX. I.H.P. PER 1000 LBS. TRACTIVE EFFORT (2.4-9) 1000				48.3		53.3			38.8	42.9	50.6		54.7					46.7	63.3				50.9			56.2				71.6	78.9			37.2
30	WT ON DRIVERS PER 1000 LBS. TRACTIVE EFFORT (1.8-9) 1000	4100	4720	4025	3720		3580	3350	3920	3800	3914	3620	4050	4100	3596	4480	4248	3920	3810	4460	3666	4475	3910	3670	4050	4525	4230		4080	5920	4530	4200	4250	4160	4466
31	TOT. WT OF ENG. PER 1000 LBS. TRACTIVE EFFORT (1.8-9) 1000	4590	5300	5280	5170		5550	5250	4670	4125	4290	5400	5875	5530	4675	5050	4920	5695	5710	6060	5340	6475	6375	5120	6825	7410	5930		6820	9280	6950	7925	9450	8750	5060
32	GRATE AREA SQ. FT. PER 1000 LBS. TRACTIVE EFFORT (1.8-9) 1000	1.165	1.236	1.095	1.107	1.115	1.44	1.33	9.22	1.79	1.79	1.205	1.216	1.00	.76	1.995	1.037	1.295	1.3	1.255	1.935	1.39	1.42	1.12	1.485	2.00	1.085	1.64	1.485	1.935	1.56	1.80	1.015	1.16	1.122
33	GRATE AREA SQ. FT. PER MAX. I.H.P. (1.8-24)	0.976			0.214		0.27			0.2065	0.1815	0.230		0.1825					0.278	0.198				0.22			0.193				0.218	0.19			0.308
34	GRATE AREA SQ. FT. PER TOT. EVAP. H.S. (1.9-17)	0.173	0.19	0.165	0.176	0.163	0.195	0.206	0.134	0.1618	0.1465	0.193	0.18	0.159	0.152	0.176	0.188	0.186	0.178	0.167	0.173	0.197	0.178	0.185	0.198	0.249	0.149	0.191	0.201	0.149	0.172	0.182	0.276	0.264	0.1825
35	GRATE AREA PER SQ. FT. OF TUBE AND FLUE H.S. BASED ON 2-6-0 (2.2)	0.1268	0.153	0.169	0.1645	0.166	0.2091	0.2241	0.147	0.1645	0.148	0.231	0.209	0.214	0.193	0.226	0.251	0.202	0.206	0.1887	0.192	0.227	0.199	0.226	0.238	0.292	0.155	0.222	0.205	0.170	0.176	0.199	0.379	0.332	0.1465
36	FIRE BOX VOL. CU. FT. PER 1000 LBS. TRACTIVE EFFORT (1.8-9) 1000	5.26	5.96	6.65	5.93	6.11	6.7	6.34	4.375	4.04	4.04	7.1		8.29		6.49	7.65	8.3	8.39	6.06			7.27	9.29	7.05	11.38	8.04	9.58		10.75	9.6	8.6			6.56
37	FIREBOX VOL. CU. FT. PER MAX. I.H.P. (1.8-24)	2.15			1.23		1.255			1.042	0.962	1.401		1.51					1.79	1.27				1.827			1.43				1.34	0.868			1.22
38	FIREBOX VOL. CU. FT. PER SQ. FT. GRATE AREA (1.8-16)	4.52	4.82	6.06	5.84	5.475	4.65	4.78	4.75	5.2	5.2	5.89		8.28		6.55	7.4	6.41	6.44	6.4			5.12	8.3	5.29	5.67	7.42	5.82		5.47	6.18	4.55			4.03
39	FIREBOX VOL. CU. FT. PER SQ. FT. NET GAS AREA (1.9-20)	3.65	3.61	4.33	4.42	3.89	4.38	4.68	3.62	3.6	3.86	4.22		7.3		6.2	7.6	5.2	5.43	4.96			4.48	7.81	5.44	6.42	5.34	5.72		4.82	4.68	3.72			2.875
40	FIREBOX H.S. SQ. FT. PER SQ. FT. GRATE AREA (1.8-16)	3.38	3.76	4.65	5.44	4.25	3.41	4.05	3.3	4.14	4.11	5.37	4.2	9.36	3.9	4.14	5.24	5.36	4.65	4.725	6.475	5.3	3.8	5.45	5.2	4.22	5.65	4.98	4.34	4.08	4.43	3.35	1.665	1.485	3.38
41	NET INT. GAS AREA SQ. FT. PER 1000 LBS. TRACTIVE EFFORT (1.9-1) 1000	1.445	1.64	1.535	1.34	1.57	1.525	1.355	1.45	1.12	1.048	1.14	1.27	1.135	0.953	1.64	1.005	1.575	1.545	1.616	1.198	1.585	1.625	1.190	1.44	1.641	1.505	1.674	1.76	2.275	1.205	1.22	0.961	1.05	1.575
42	NET INT. GAS AREA SQ. FT. PER MAX. I.H.P. (2.6-24)	0.058			0.0775		0.087			0.0289	0.0244	0.025		0.0207					0.0329	0.0256				0.0233			0.0256				0.0206	0.0225			0.0425
43	NET INT. GAS AREA SQ. FT. PER SQ. FT. FACTORIAL TRACT. EFFORT (1.8-9) 1000	0.0281	0.0272	0.0249	0.0256	0.0246	0.0221	0.0225	0.0221	0.0225	0.021	0.0209	0.0204	0.0212	0.0208	0.0198	0.0202	0.0256	0.023	0.0237	0.0234	0.0238	0.0217	0.0218	0.0215	0.0227	0.0225	0.0215	0.0263	0.0187	0.0244	0.0229	0.0478	0.0371	0.0273
44	NET INT. GAS AREA SQ. FT. PER SQ. FT. TUBE & FLUE H.S. BASED ON 2-6-0 (2.2)	0.0157	0.0203	0.0237	0.0243	0.0233	0.0221	0.0225	0.0232	0.0238	0.0175	0.0218	0.0219	0.0194	0.0242	0.0238	0.0243	0.0249	0.0241	0.0243	0.0223	0.0246	0.0227	0.0206	0.0232	0.0226	0.0215	0.0225	0.0236	0.0220	0.0236	0.0235	0.0359	0.0492	0.0285
45	NET INT. GAS AREA SQ. FT. PER SQ. FT. OF GRATE (2.0-19)	1.24	1.34	1.40	1.318	1.41	1.06	1.02	1.57	1.445	1.348	0.946	1.048	1.136	1.25	1.05	1.097	1.23	1.185	1.289	1.2	1.085	1.142	1.06	0.97	0.821	1.39	1.017	1.185	1.18	1.318	1.185	0.967	0.967	1.40
46	TOT. EVAP. H.S. SQ. FT. PER 1000 LBS. TRACTIVE EFFORT (1.7-1) 1000	6.74	6.5	6.66	5.77	6.8.6	7.4	6.425	6.8.0	9.81	5.3	6.25	6.75	6.3	5.02	5.6.0	5.51	6.94	7.3	7.43	5.76	7.1	8.02	6.06	7.5	8.03	7.275	8.6	7.35	12.25	9.05	10.35	3.69	4.42	6.16
47	TOT. EVAP. H.S. SQ. FT. PER MAX. I.H.P. (1.7-26)	2.71			1.195		1.385			1.242	1.235	1.235		1.148					1.56	1.17				1.191			1.295				1.265	1.045			1.655
48	TOT. EVAP. H.S. SQ. FT. PER SQ. FT. OF GRATE AREA (1.7-14)	57.95	52.7	60.8	56.9	61.5	51.23	48.5	74.6	61.9	68.3	51.8	55.6	62.9	65.9	57.5	53.2	53.6	56.2	59.25	57.75	51.	56.31	54	58.5	44.2	67.2	52.3	49.5	67.	58.3	55.	36.4	38.1	56.75
49	TOT. EVAP. H.S. SQ. FT. PER SQ. FT. O.F.B. H.S. (1.7-16)	17.1	14.05	13.	10.5	14.45	13.02	11.95	22.7	14.9	16.6	9.65	13.22	6.725	16.95	13.9	16.15	10.0	12.1	12.52	12.925	9.6	14.81	9.82	9.73	9.525	11.87	10.5	11.15	16.5	13.1	15.95	2.17	2.57	16.2
50	SUPERHEATER H.S. SQ. FT. PER SQ. FT. TOTAL E.H.S. (1.8-17)		1.95	2.05	2.77	2.63	2.2	2.375	1.95	3.42	3.81	4.05	4.23	2.61	2.7	2.80	2.98	2.97	2.63	2.35	2.29	2.61	4.4	2.36	2.32	2.26	3.5	4.28	2.61	1.85	2.91	4.38	2.22	2.26	1.98
51	RAILROAD	P.R.R.	N.Y.C.	C.B.Q.	MO. PAC.	OMAHA	L.I.M.A.	C.B.&N.W.	A.T.&S.F.	P.R.R.	P.R.R.	TEX. PAC.	C.B.&Q.	B.L.W. 60,000	G.T. NOR.	C.B.Q.	D.&R.G.	D.&R.G.	L.V.	N.Y.C.	N.Y.N.H. & H.	CAN. PAC.	ERIE	U.P.	CAN. NAT.	NOR. PAC.	P.R.R.	SANTA FE	CAN. PAC.	N.Y.C.	P.R.R. 17.3.7	N.Y.C.	NORFOLK & WEST.	JULIEN	P.R.R.
52	CLASS OR TYPE	2-8-0	2-8-0 G-5	2-8-2 K-3	2-8-2	2-8-2	A-1	2-8-4	2-10-2	2-1-1-2	2-1-1-2	2-10-4	2-10-4	2-10-2	2-8-2	2-8-2	2-8-2	2-8-2	4-8-2	L-2	4-8-2	4-8-2	2-8-4	4-12-2	4-8-4	4-8-4	4-8-2 K-1	4-8-4	4-6-4	4-6-2 K-2	4-6-4 K-4	4-6-4 J-1	2-8-0	2-8-0	2-8-0 H-8-S

Fig. 2—Locomotive and boiler dimensions, ratios and proportions

of superheat obtained with the Type E superheater, coupled with a somewhat higher pressure and better steam distribution in the cylinders, this steam rate has been materially reduced.

Numerous tests have been made showing a steam rate as low as 15 to 16 lb. per indicated horsepower-hour at maximum capacity. It is, therefore, suggested that when a locomotive is designed to use steam superheated to 300 deg. F., a pressure of from 225 to 275 lb., a feedwater heater and large grates, a steam rate of 17½ lb. per indicated horsepower including auxiliaries, can be safely used.

General boiler design

With these important points in mind, we now come to sure is meant boilers carrying upwards of 300 lb. pressure. When reviewing the accomplishments, however, that have been made in the design of the most recently constructed standard type of locomotive having a Type E superheater and a feedwater heater with a pressure around 225 to 250 lb., it appeared that the most valuable contribution I could make at this time was to analyze the reasons for the remarkable improvements made in the last ten years, using the conventional designs.

There has recently been placed in service a 4-6-4 passenger locomotive, ratios, Fig. 2, column 31, that has developed 4,295 i. hp. with a weight on the drivers of 42.3 lb. per i.hp., and a total weight per engine of 80 lb. per i. hp. when pulling a train of 26 steel passenger coaches at 67 m.p.h. When you

find that this has been done with a boiler and superheater efficiency of 78.6 per cent, an average steam consumption of 17.14 lb. per hp.-hr. and a coal consumption of 2.09 per i. hp.-hr., including all auxiliaries, then you must sit up and take notice. These figures are average results of many tests, and the best average results on any single run with this train were an average boiler and superheater efficiency of 84.2 per cent, a steam consumption per i. hp.-hr., 15.04 lb. and 1.89 lb. of coal fired per i. hp.-hr. This included all auxiliaries. The coal per drawbar hp.-hr. was 2.68 lb. and the maximum temperature of steam was 750 deg. F.

Fig. 3 shows the comparison between tractive force and cylinder horsepower calculated from Cole's formula and the tractive force and power actually obtained from test.

A recent large freight locomotive of the 4-12-2 type has developed a maximum of 4,917 i. hp. with a weight

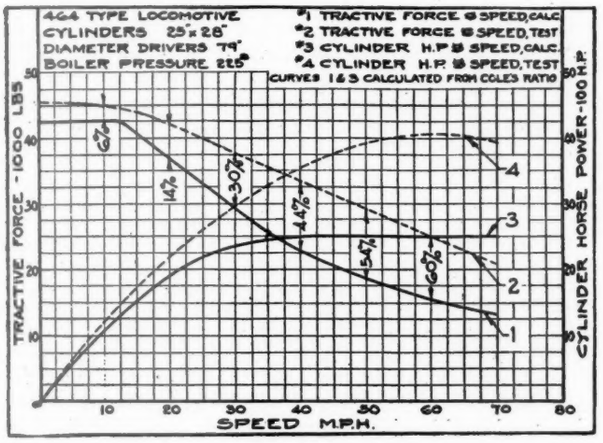


Fig. 3—Actual horsepower and tractive force at speeds exceed the calculated, in modern locomotives

on the drivers of 72.3 lb. per i. hp. and total weight of 101 lb. per i. hp. This is very remarkable for a heavy freight locomotive and represents, as far as I know, the heaviest power output recorded.

Another locomotive of the 4-8-2 type having a total engine weight of 95.8 lb. per i. hp. pulled a freight train of 122 cars of 9,315 tons at a maximum speed of 34.8 m.p.h. and an average speed of 18.25 m.p.h. wit'ı a coal consumption of 2.59 lb. per drawbar hp.-hr., including all auxiliaries. This performance was equalled by another locomotive of the 2-8-4 type hauling 9,324 tons at 18.3 m.p.h. average speed on 2.50 lb. of coal, per i. hp.-hr. The drawbar pull-speed for this 4-8-2 type is shown in Fig. 4.

There have been several reciprocating steam locomotives built in the last few years carrying over 300 lb. boiler pressure. All are constructed with water tube fireboxes and compound cylinders as follows: One with 350 lb. and one with 400 lb. boiler pressure by the Delaware & Hudson, the Baldwin No. 60,000 with 350 lb. pressure, and the Schmidt-Henschel locomotive carrying 880 lb. and 200 lb. The performance of the D. & H. locomotive is not known, but that of the Baldwin No. 60,000 has been published.

The increase in the theoretical thermal efficiency by the use of high pressure is well known to all students of this subject. Lawford Fry, metallurgical engineer, Standard Steel Works Company, pointed out in a recent paper that the theoretical thermal efficiency of the locomotive cycle will increase from 14.2 per cent at 220 lb. to 17.9 per cent at 450 lb. and 20.7 per cent at 600 lb. absolute pressure.*

To obtain the benefit of high pressure, it is clear that a high ratio of expansion must be used by compounding, and the three-cylinder arrangement makes this quite simple and practical. When we consider the remarkable efficiency now obtained with a 225-lb. pressure locomotive with a Type E superheater and a feedwater heater, it seems that in order to get a return on the investment and maintenance cost of water tube fireboxes and compound cylinders, a steam consumption of from 10 to 12 lb. of steam per i. hp.-hr. should be obtained and a coal consumption well below two pounds per drawbar hp.-hr.

The water tube firebox

It was a courageous step when the steam pressure for the staybolt boiler was jumped from 200 to 250 lb. Thousands of these are now operating successfully. Recently 265 lb., 275 lb. and 300 lb. boiler pressures have been used on a few locomotives. Whether a 300-lb. staybolt boiler will prove satisfactory, only experience will tell. The general opinion among the best authorities now is that above 250 lb. or 275 lb. pressure, a water tube firebox is the safest and most desirable.

The water tube firebox is an old design. It was first designed 30 years ago by the eminent Russian engineer, J. Brotan. Several locomotives were built in 1904. C. Noltein reported on these locomotives to the International Railway Congress in 1910 as being satisfactory.

The reason why the Brotan boiler has not been placed in general use throughout the world is probably due to the great difficulties experienced and the time required to keep the water tubes free from scale. Where good feedwater is available, we know from the experience of the New York, New Haven & Hartford and the Dela-

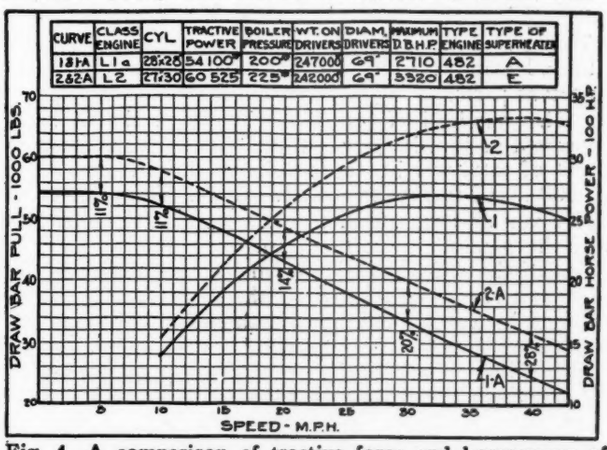

CURVE | CLASS ENGINE | CYL. | TRACTIVE POWER | BOILER PRESSURE | WT. ON DRIVERS | DIAM. DRIVERS | MAXIMUM D.B.H.P. | TYPE ENGINE | TYPE OF SUPERHEATER
1&1A | L1a | 28x28 | 54100# | 200# | 247000 | 69" | 2710 | 4&2 | A
2&2A | L2 | 27x30 | 60525 | 225# | 242000 | 69" | 3320 | 4&2 | E
DRAW BAR PULL - 1000 LBS.
DRAW BAR HORSE POWER - 100 H.P.
SPEED - M.P.H.
11%
11%
14%
20%
28%

Fig. 4—A comparison of tractive force and horsepower of similar locomotives, differing in boiler pressure, cylinder sizes and in the type of superheater

ware & Hudson, that a water tube firebox can be satisfactorily maintained.

Unfortunately there are only a few places in the world where pure water for locomotive use is available. In localities of bad or even normal water conditions, the loss of time and cost of keeping the water tubes clean might be very high. It appears, therefore, logical that the only water tube firebox that can be satisfactorily used is one where only pure, or preferably, distilled water is used in the water tube end of the boiler.

This paramount requisite for successful operation of the water tube firebox is incorporated in the principle

* See the August, 1927, *Railway Mechanical Engineer*, p. 527.

used by the Schmidt-Henschel locomotive referred to, where the steam used by the cylinders is evaporated by means of indirect heat and then condensed in heat interchange coils located in the steam drums, the condensate returning to the bottom of the firebox headers, thus forming a closed cycle.

While this design was particularly evolved for a high pressure locomotive, this form of construction may prove of advantage with lower pressures as well. It would seem, however, that the many apparent advantages of a water tube firebox will be developed into a practical construction supplanting the staybolt type of firebox.

Boiler ratios

I have shown some of the older locomotives in the table in Fig. 2 to add to the interest of this comparison.

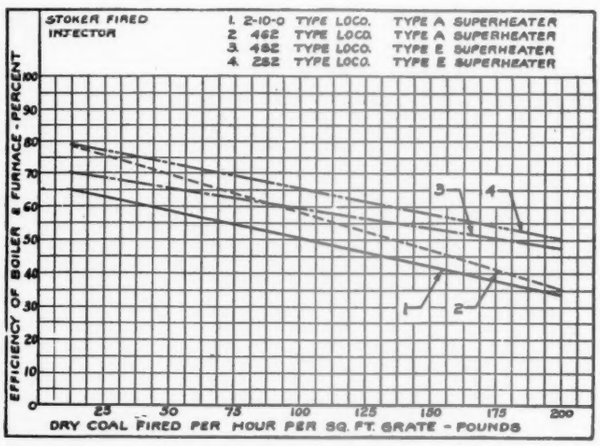


Fig. 5—Relation of the combustion rate to boiler efficiency

This table shows the principal dimensions of some of these locomotives and also the ratios of some of the important parts.

The standard of excellence in design should be the locomotive that has given the highest power output per unit of total weight, the weight on the drivers and per 1,000 lb. of theoretical tractive force. These ratios will give you an accurate picture not only of the excellence of the general proportions and over-all efficiency, but also of the refinement in the mechanical design. Only locomotives in approximately the same class of service should be directly compared with each other.

It is to be regretted that actual dynamometer tests are not available for all of these modern locomotives, but it is known that the performance of the others shown has been excellent and probably equalled those for which tests have been published.

It is evident that it is impractical to lay down a definite rule or ratio that would fit any given condition. All rules and ratios must be used with great care and analyzed in the light of actual conditions to be met. There are certain fundamentals, however, that must not be lost sight of and it is the intention to present and tabulate here the facts available to aid in properly designing a locomotive boiler with as little theoretical speculation as possible and at the same time, give assurance that the best possible locomotive will result.

The locomotive ratios developed by the late F. J. Cole, published in 1917, have in the past been the most authoritative information on this subject. These were based on many years experience and tests on locomotives in general use at that time. There has been a gradual tendency away from these ratios, however, in the last few years and there is now a great need for a decided revision in these previously accepted standards of proportion. Many tests have been conducted on several recent locomotives and these have given us much valuable data, which if wisely interpreted should help in future design.

Boiler efficiency

When the performance of a locomotive boiler is analyzed, one immediately notices that the efficiency decreases rapidly as the rate of firing increases, or from about 75 to 80 per cent with a coal rate below 40 lb. of coal per square foot of grate per hour to about 40 to 45 per cent efficiency with a coal rate of around 200 lb. per sq. ft.

A number of curves are plotted in Fig. 5, showing the boiler efficiency vs. the rate of firing. It will be noticed that some curves are considerably higher than others while other curves show a different slope. It is thus clear that there must be some factors entering into the proportion of the boilers that have a great influence upon the efficiency for any given rate of firing, as well as upon the rate of decrease as the rate of firing increases. The principal factors that are responsible for the great heat loss, as the output increases, are as follows:

First—Imperfect combustion producing carbon monoxide
Second—External radiation from the boiler and firebox
Third—Loss of heat in the smokebox gases
Fourth—Unburned fuel escaping from the boiler. This heat loss increases very rapidly on the older type of boiler as the rate of firing increases. Numerous tests have shown that this heat loss will run from 15 to 20 per cent at a 60-lb. coal rate, up to as high as 50 per cent when the coal rate is 200 lb. per sq. ft.

This is due to the fact that the grate area and furnace volume are too small to give the carbon and volatile combustible time to mix intimately with the oxygen and burn before they enter the flues and is also due to the small gas area through the boiler, which causes too high a gas velocity and draft loss through the flues. It is clear, therefore, that a great gain in boiler efficiency will result from any effort that will improve these conditions.

Grate area and furnace volume

The various factors entering into this problem are the grate area, the percentage of air opening through the grate, the firebox heating surface and volume, together with the arrangement and length of flame travel, and the gas area through the boiler.

Up to very recent years there has been a reluctance on the part of locomotive designers to increase the grate area ratios above those commonly used in years past. Interest, however, has been aroused on this question and recent locomotives have been built with a much larger grate ratio than heretofore. Arguments have been advanced against large grates, a prominent one being that the so-called standby losses would be unduly increased.

This reason, I believe, is not well founded, as the coal burned when the locomotive is not working is largely determined by the blower draft, and there would not be much difference in the total standby coal burned with a large or small grate if the fireman pays any attention to his job.

Furthermore, the radical change in locomotive operation in the last few years has minimized the item. A few years ago, the average locomotive run was about 150 miles at the end of which the fire was dumped,

while nowadays the locomotive runs have been lengthened to from 600 to 800 miles and fires are only dumped when it is necessary to hold the locomotive for repairs.

The determination of the correct grate area may seem at first glance to be a simple matter, but in reality it is quite involved. The total amount of coal to be burned per hour should first be determined. This, however, is influenced greatly by the efficiency of the boiler and cylinder so that most careful consideration should be given to these conditions before the maximum total is determined. The question of pounds of coal per square foot of grate, for maximum output is the important question to settle.

Mr. Cole in his studies of ratios recommended a maximum rate of 120 lb. per hr. per sq. ft. It is now believed by many competent designers that this is too great for maximum efficiency. A rate of 80 lb. may now be considered a good average maximum. The quality or heat value of the coal should also be considered. It is evident that if coal containing 9,000 B.t.u. per pound is used, 45 per cent more coal must be fired to give the same heat as when coal containing 13,000 B.t.u. per pound is used. For average conditions, however, the quality must be disregarded to some extent as locomotives on large railroad systems are likely to burn coal ranging from the best to the poorest from one end of the run to another. A heat value of 12,000 B.t.u. per pound can, I believe be considered a fair average, for design purpose. This may be criticized by some as too low, but it is an error in the right direction. That a large grate area and a consequent low rate of firing has a most important bearing on the overall efficiency of the boiler will be evidenced from examination of the boiler efficiency curves plotted in Fig. 5. Fig. 5 shows the overall boiler efficiency plotted against coal rate for stoker fired locomotives with Type A and Type E superheaters and without feed water heater. Stoker fired engines only are considered in these comparisons.

It is interesting to note from the data and ratios shown in items 27, 28 and 29, Fig. 2, that the locomotives which have the greatest sustained power per unit of weight or tractive force, are those that have a large grate area ratio. It appears that on locomotives with 63-in. drivers a ratio of grate area per 1,000 lb. tractive force, of 1.245 to 1.44 have given the better result than those with a smaller ratio. For locomotives with 72- and 75-in. wheels a ratio of 1.48 to 1.65 has been used with most gratifying results. The locomotive in column 25, Fig. 2, with a ratio of 2 sq. ft. per 1,000 lb. tractive force, is burning a special light coal of low heat value. The most efficient high speed passenger locomotive for which complete test data is available, shown in column 31, Fig. 2, has a ratio of 1.88.

A typical example of what happens when the coal rate is forced too high is illustrated in a capacity test made by the Pennsylvania which was published in its bulletin No. 32. The maximum evaporation of 62,000 lb. of water per hour was reached when firing 11,070 lb. of coal per hour or a rate of 159 lb. per sq. ft. of grate, giving about 50 per cent boiler efficiency. The firing rate was increased to 16,000 lb. of coal per hour or a coal rate of 229 lb. with practically no increase in the evaporation, showing a boiler efficiency of 35 per cent. Thus practically all coal fired above the coal rate of 159 lb. was wasted in this locomotive.

Grate bar construction

In discussing the efficiency with which the fuel is burned, I mentioned that the design of the grate bar is of great importance. Up to a few years ago, the general practice on locomotives burning bituminous coal has been to use grates having an air opening of approximately 40 to 50 per cent of the total grate area. Within the last few years investigations have been carried on in order to determine if this general practice could be improved upon. Committees of the Traveling Engineers Association and others have in the past recommended that the size of the individual air opening through the grate should be made to suit the fuel to be burned but that the aggregate total air opening through the grate should be as large as possible.

As a result of these recommendations, the present practice of a large air opening through the grate has become general. The investigations carried on, however, by such railroads as the Santa Fe and the Northern Pacific have in the past two years shown that a considerable improvement in the efficiency can be obtained by decreasing the total amount of air opening through the grate. The tests conducted showed that grates having a large percentage of air openings between 40 and 50 per cent permitted too large a quantity of air to enter the furnace for proper efficiency. In pursuing these investigations through analysis of the smokebox gases, it was found that the aggregate percentage of air openings could be reduced to about 12 to 16 per cent of the total grate area. This seems logical, as even with as small an air opening through the grate as 12 per cent, the velocity of the air will be considerably less than the velocity of the hot gases through the flues. As the internal net gas area through the boiler usually is from about 9 per cent to 13 per cent of the grate area, the velocity of the air through the air opening in the grate will be approximately one-fifth of that through the flues, due to the fact that the specific volume of the hot gases entering the flues is about five times that of the cold air entering through the grate.

(Part II, which will appear in the May issue as the concluding installment of Mr. Brandt's paper, contains a discussion of firebox heating surface, the evaporating rates for tubes and flues, and the results obtained with superheaters and feedwater heaters.—Editor.)

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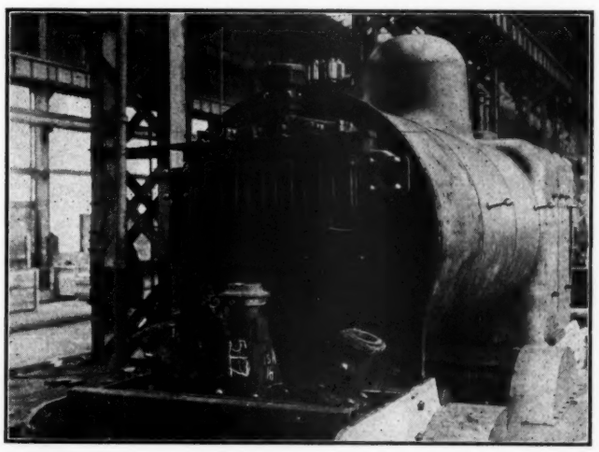
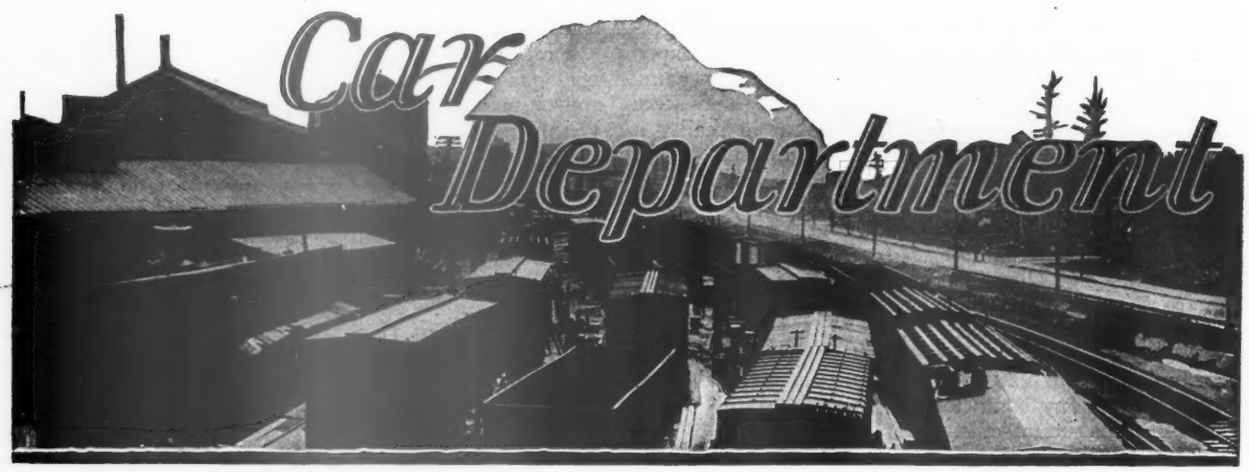


Unique boiler construction incorporated into the design of British locomotives by Sir W. G. Armstrong, Whitworth & Co., Ltd., Manchester, England. The lower part of the smoke box is flanged square and is secured directly to the frame and cylinder castings

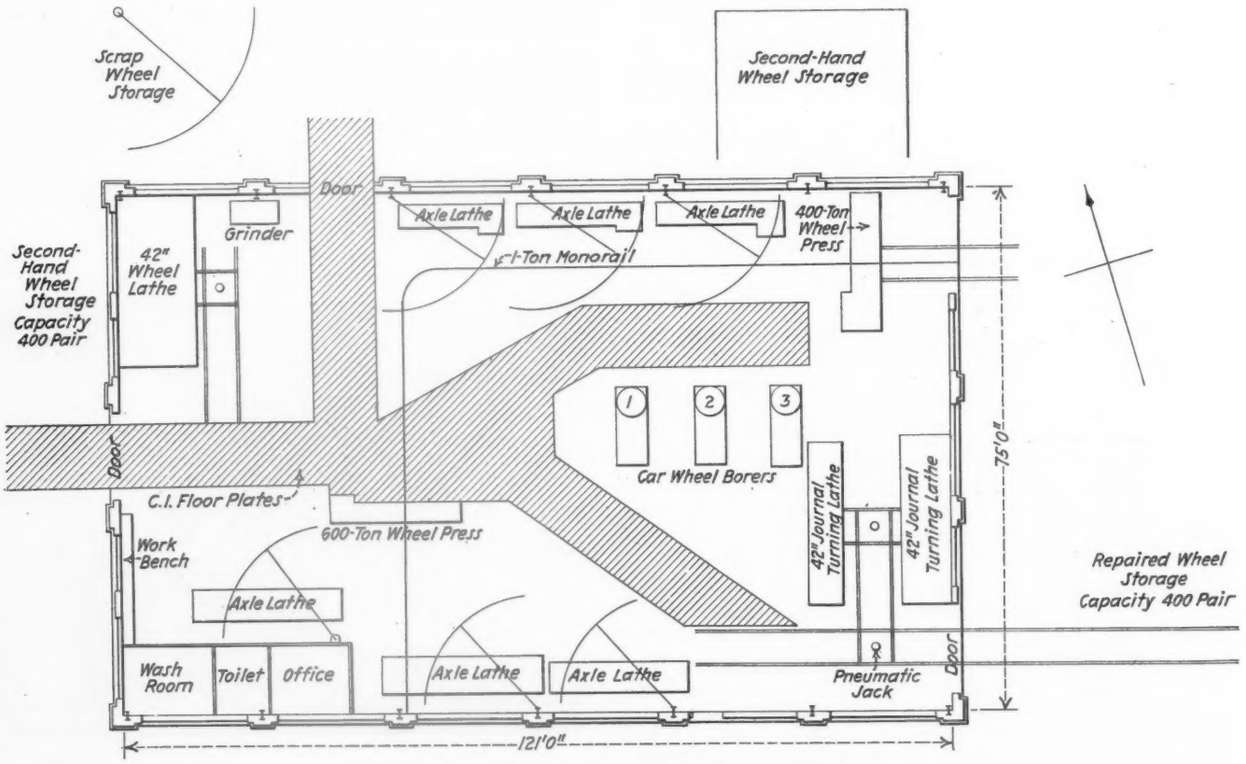


Big four wheel shop at Beech Grove

Shop handles large part of wheel work for entire road— Wheel handling facilities speed up the work

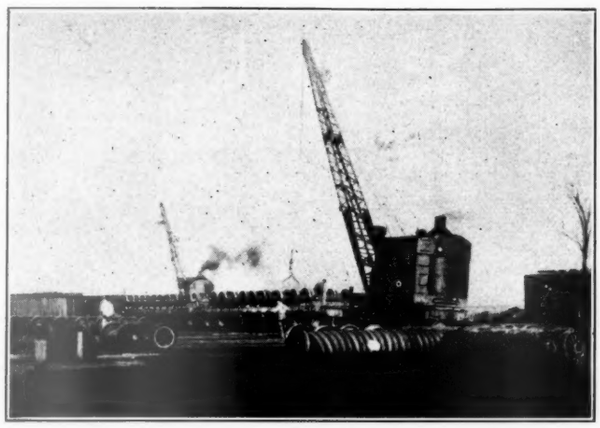
THE Cleveland, Cincinnati, Chicago & St. Louis wheel shop located at the company's principal repair point at Beech Grove, Ind., has, within the last two or three years been improved in layout and equipment with the object of increasing capacity and output to a point where, eventually the major portion of the wheel work for the entire road may be handled at this one shop.

The shop building proper is a 75-ft. by 121-ft. steel and brick structure. The layout of shop facilities and machine tool equipment is shown in one of the drawings. At the west end of the building the incoming wheels are stored and inspected. In this space transverse storage tracks are provided for approximately 400 pairs of mounted wheels. At the opposite end of the shop a storage space of similar capacity is located



Plan of the Big Four wheel shop at Beech Grove

for remounted wheels awaiting shipment. On the north side of the shop the space is used for the storage of second hand unmounted wheels and scrap wheels. Crane facilities are provided here for loading the scrap wheels into cars.



Unloading wheels for the shop with locomotive cranes

Shop equipment

The shop is arranged in such a manner that the work moves through the shop from west to east without doubling back at any time during the process. As may be seen from the layout the machine tool equipment consists of the following units:

1 42-in. car wheel lathe for tire turning
6 Axle lathes
1 600-ton double-end hydraulic demounting press
1 400-ton single-end hydraulic mounting press
2 Combination journal turning lathes
3 48-in. car wheel boring mills
1 Double emery floor grinder

A one-ton overhead electric monorail crane in conjunction with jib cranes of like capacity serve all of the axle lathes and the two hydraulic presses. Cast iron plates are used as a floor surfacing throughout those parts of the shop where it is necessary to roll wheels constantly as it has been found that these give more satisfactory service under the conditions than wood or concrete and are easily renewed at small expense.

A view outside the wheel shop showing the finished wheel storage

Organization

At the present time the force consists of 11 machinists, 10 helpers, one laborer and three inspectors, a total of 25 men exclusive of supervisors. With the exception of the piece-work inspector, shop inspectors and laborer, the shop is operated on a piece work basis. There is one piece work inspector and two wheel inspectors; one on cast iron wheels, the other on steel wheels. The steel wheel inspector keeps all wheel records and the cast iron wheel inspector handles the shipping as well as the checking of wheels. Two helpers are continually engaged in unloading and loading wheels. Most of this outside work is handled with the aid of locomotive cranes. These same two helpers keep the boring mill operators supplied with wheels and move wheels from storage to the tire lathe and mounting press. Three helpers are assigned to the demounting press and in addition to this work distribute the axles to the several axle lathes and move the demounted wheels from the press to the scrap or second-

The Cleveland, Cincinnati, Chicago & St. Louis Railway Company

Page No._____

Station_____ Date_____ 19____

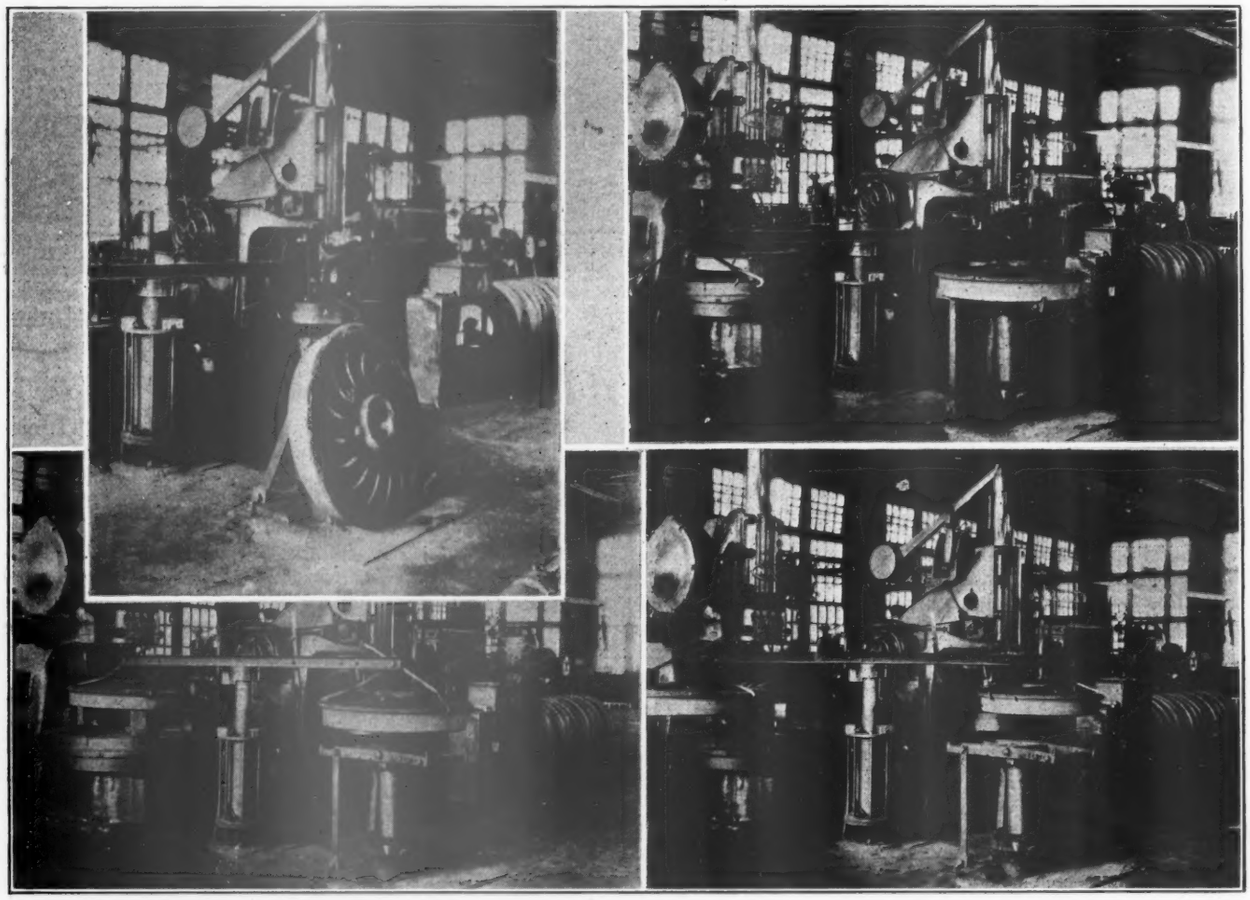
WHEEL SHOP RECORD OF WHEELS AND AXLES RECEIVED_____ 19____ FROM_____ LOADED ON_____

INITIAL AND NUMBER	WHEELS — Maker	Railway Co's. Initials On Wheels	Wheel Number	Data Cast	SERVICE METAL Before Turning FF	SERVICE METAL Before Turning Amount	SERVICE METAL After Turning Amount	Standard Removal Gauge Defects	Remounting Gauge Defects	AXLES—ACTUAL DIMENSIONS A.R.A. or Non-A.R.A.	JOURNAL Length	JOURNAL Diameter	Wheel Seat Diameter	Center Diameter	Condition	REMARKS

_____ Indicate by Yes or No in column headed FF whether or not Wrought Steel Wheels had full flange and tread contour before turning.

Wheel defect tag and wheel shop record form

hand storage. The 11 machinists are assigned respectively to the wheel lathe, journal lathes, axle lathes and boring mills. Three helpers are assigned to the mounting press whose duties are to get the axles and wheels from the points where they are placed by lathe and boring mill operators, to mount them in the press, paint the journals and, finally, remove them to the outside storage. One helper is assigned to outside work to assist in loading wheels, blocking the wheels on the cars, painting journals, etc.



Upper left: demounting press—Upper right: mounting press—Lower left: north side of the shop—Lower right: the journal lathes

How the wheels are handled

When wheels are removed from a car for defects at outlying points they are tagged with a wheel defect tag "K" shown in one of the illustrations. This tag shows a record of the place and date of removal, the car record, and a list of wheel and axle defects on which the inspector checks the defects which caused the wheel to be removed. With this record the wheels are shipped to the wheel shop at Beech Grove where they are unloaded and placed in the shop storage. The defect tag does not indicate on which of the pair of wheels the shop inspector may look for the defects noted, it being his duty to find them himself. The shop inspector makes a complete record on the "wheel shop record blank" also illustrated. A copy of this wheel report is kept at the shop while the original is sent to the chief A. R. A. clerk for billing and checking purposes. The shop inspector after completing his inspection marks the wheels either "second-hand" or "scrap." In either case the wheels then pass into the shop to the demounting press where the wheels are pressed off from the axles and the unmounted wheels, if for scrap are rolled out to the scrap storage to await loading while the second hand wheels are either held in the shop for remounting or go to the outside second-hand wheel storage. Second-hand axles are handled from the press by the overhead monorail to the axle lathes. The scrap axles are removed to a separate pile which is removed by the stores department to a reclaiming shop where they are upset in a forging machine to smaller sizes. The 5-½-in. by 10-in. axles are upset, to form 5-in. by 9-in. and the 5-in. by 9-in. are upset to form 4¼-in. by 8-in. After reforming, these axles are returned to the wheel shop and are treated as new axles of the smaller size.

Second-hand mounted wheels which have been sent to the shop because of axle defects which necessitate only the turning of journals, are brought into the shop and taken directly to the journal turning lathes at the east end of the shop. These two lathes are depressed below floor level and at the track intersections pneumatic jacks are provided in the floor for handling the wheels.

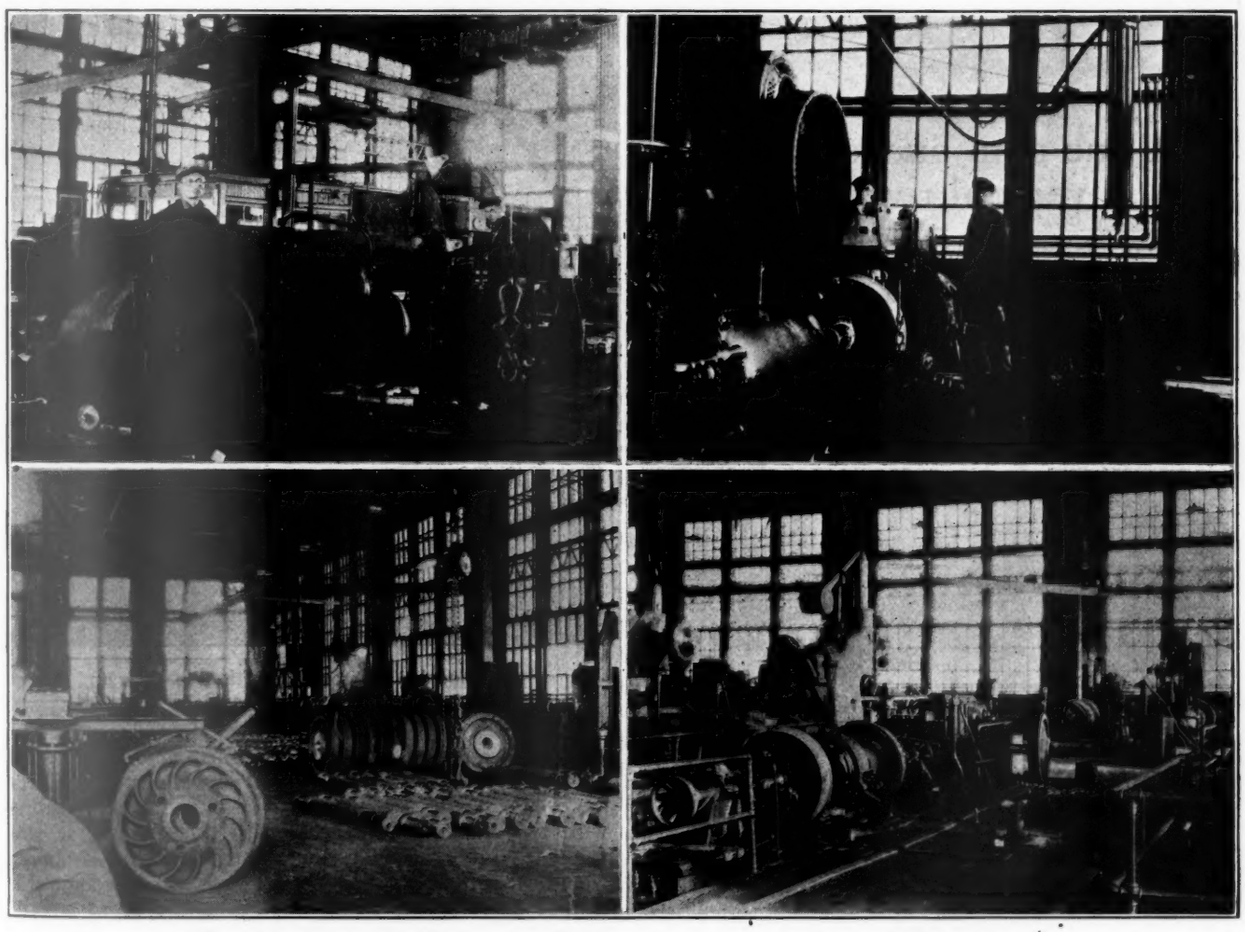
How axles are handled

The work in the shop as far as axles are concerned consists of three classes of axles; new, reclaimed and second-hand. Under present conditions approximately 2,500 axles a month are handled. As far as new axles are concerned, they are finished complete in one machine which includes the rough and finish turning of

the wheel fits and journals and the rolling and polishing of journals. As previously mentioned, reclaimed axles, after being returned to the wheel shop, are treated the same as new axles.

The second-hand axles, after coming from the demounting press, are placed in piles at the several axle lathes. They are taken from these piles as needed by the lathe operator, placed in the lathe and the journals trued up rolled and polished. When necessary the wheel fit is trued up. If not, the lathe operator chalk-marks the wheel fit "o. k. for mounting." The axles are then taken from the lathe and placed in a separate pile on the floor where they are inspected by the piece-work inspector and given consecutive numbers.

The shop is equipped with three car wheel boring mills, two of which are modern machines. The third, shown as No. 1 on the machine tool layout, is a somewhat older machine. No. 1 boring mill is equipped with a small crane for handling the wheels which is a part of the machine. Boring mills Nos. 2 and 3 have been fitted up with a special wheel handling device which is clearly illustrated in the accompanying pictures. It consists of a special elevating floor jack with a rack against which the wheels are rolled in an upright jack having a swivel head to which is attached a swinging beam having special hooks at each end operated from a single lever near the center. When the operations on the wheel on the boring mill have been completed the beam is swung over both wheels, the hooks grasp the flange of each wheel on opposite sides and by applying air pressure to the jack both wheels are raised up. The beam is then swung around through a half circle which places the finished wheel over the rack on the floor jack and the unfinished wheel over the boring mill table. The air pressure is released and the wheels are let down and the hooks released. The boring mill operator then chucks the wheel on the machine and starts the boring operation. After this, the air is released on the floor jack which lowers the finished wheel to a position on the floor from which it is rolled away and another one put in its place to repeat the operation. By means of this device, it is possible to complete the operations on a wheel in as short a time as 2 min. 20 sec. On an average the floor to floor time for wheels on the machines equipped with this device on all-day production is about 4-½ min. On this machine the average production is 106 cast iron wheels for each eight-hour day. The No. 1 boring



Wheel loading device—By means of the floor jack and swinging beam the wheels are handled from floor to boring mill table

position. When the air pressure is applied to the jack the wheel is raised up to a horizontal position at a height equal to that of its position when on the table of the boring mill. Midway between the floor jack and the boring mill table there is another pneumatic mill, which is an older type machine not equipped with the wheel handling device, has a capacity of 32 steel wheels or 88 cast iron wheels per eight-hour day.

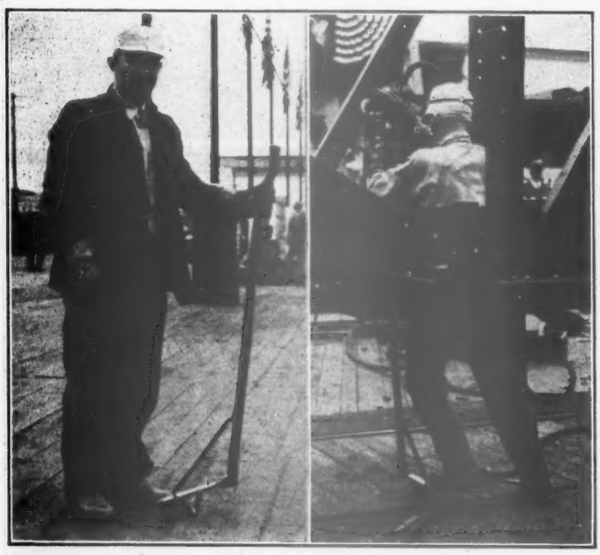
The boring mill operators set the boring tools on the machine to bore wheels within a certain range at one

time. The helpers keep the boring mills supplied with new cast iron wheels. The boring mill operators take measurements by calipering the numbered axles in the piles where they have been placed after having been through the axle lathe operations. Axles are selected by taking those on which the wheel fit diameter corresponds to the range of the boring tool setting on the boring mill at that particular time. The boring mill operator bores the wheel to correspond to the measurements taken from specific axles and then numbers the wheels to correspond to the measurements taken from the axles. Cast iron wheels with, for example, a 7-in. wheel fit are bored .016 in. under the wheel fit diameter of the corresponding axle. Steel wheels are bored .007 in. under the wheel fit diameter.

The remounting press operators take the wheels from the piles where they have been placed according to the consecutive numbers given them by the boring mill operators; then get the proper axle from the piles of finished axles at the axle lathe, mount the wheels and after completing place them in the finished wheel storage outside the east end of the shop. New steel wheels which come from the manufacturers with the tires turned are brought into the shop, bored, mounted on new axles and are placed in the outside storage ready for service.

A one-man bucker-up for vertical riveting

ONE of the devices developed for the last car building contest held by the car department of the Delaware & Hudson was a bucker-up so constructed that



With this device one man can drive and buck-up his own rivets

one man could both drive and buck up any of the vertical rivets used in the underframe of the car. The construction of the bucker-up is shown at the left in the illustration and the method of using it is shown at the right.

It consists essentially of a bar secured with a pivot hinge and a brace to a pedal lever to which is welded a vee-shaped lug which serves as a fulcrum. The upper end of the bar is shaped to suit the head of the rivet and is hardened to reduce wear. The rivet is placed in the hole from the underside, the bucker-up is placed in position and the riveter holds the rivet in place by pressing down on the pedal lever as shown.

A tractor remodeled for handling car wheels

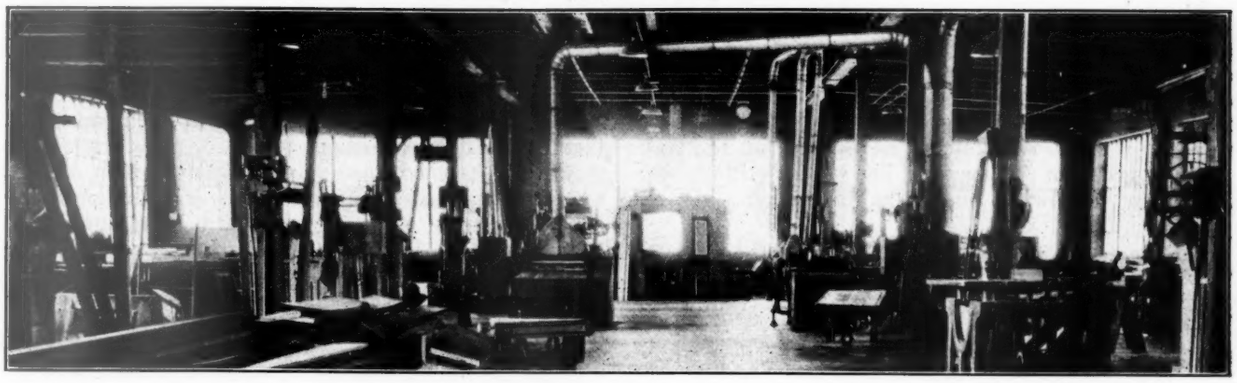
By J. E. Scott

General car foreman, Union Pacific, Cheyenne, Wyo.

THE illustration shows a caterpillar tractor which has been remodeled for handling car wheels about the yard and unloading from cars and platforms. In order to adapt this tractor to the rough traveling over the tracks,

A remodeled tractor in position to pick up a pair of car wheels

it was necessary to replace the wooden rollers with steel rollers made from scrap material and also to reinforce the platform with steel plates. When first experimenting with the handling of wheels with this tractor, it was found that the heavy weight at the end of the boom would cause the tractor to turn turtle. To overcome this trouble the clasping hooks shown on the front of the tractor just under the boom, were applied. After the axle hooks are in place, the tractor is run up close to the wheels and the clasping hooks placed over the top of the axle hooks so that the wheels when raised are drawn back snugly against the front end of the tractor, thus shifting the weight closer to equilibrium. This machine has proved of decided value as a time and money saver as it can be moved anywhere around the yard at a speed of six miles an hour.

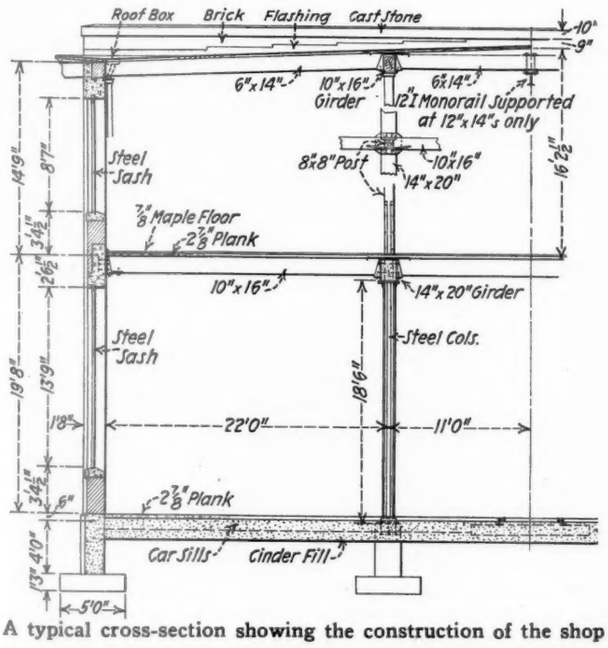


A general view of the second floor of the Maine Central wood mill at Waterville, Me.

Modern wood mill built by the Maine Central

Equipped with motor driven, high speed machine tools—Yearly output 700,000 board feet of lumber

IN 1917, the wood mill and cabinet shop of the Maine Central at Waterville, Me., was completely destroyed by fire. It was imperative that the destroyed facilities be immediately replaced. At the present time the general maintenance of all Maine Central equipment has been concentrated at this shop. The planing mill has to supply all the finished lumber and cabinet work for about 7,000 freight cars, 300 passenger cars and 600 miscellaneous service cars. In 1918, a modern fireproof woodworking shop, fully equipped with the latest types of motor driven wood mill machinery, was put in operation.



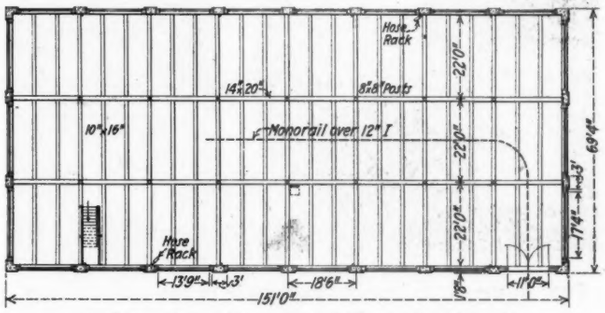
A typical cross-section showing the construction of the shop

The shop, which is 151 ft. long by 69 ft. 4 in. wide, is constructed of reinforced concrete with brick exterior panels. The steel columns rest on concrete piers set 4 ft. in the ground. The first floor consists of a 16-in. cinder fill on which rest the floor beams to which is nailed the 2⅞-in. square edge flooring. The second floor is built up of two 14-in. by 20-in. horizontal floor girders, and 10-in. by 16-in. cross joists, spaced 6 ft. 2 in. apart, support the 2⅞-in. floor planks on which is nailed ⅞-in. maple tongue and grooved flooring. The window frames and sash are made of steel.

The roof is supported by 6-in. by 14-in. beams on which are nailed 1⅞-in. spruce planks. The roof planks are covered with tar and gravel roofing. The building is heated by a B. F. Sturtevant heating system.

Shop equipped with a sprinkler system

In addition to making the building of fireproof construction, an automatic fire alarm and sprinkler system has been installed. If a fire breaks out which causes one



A floor plan of the second floor showing the location of the monorail

of the sprinklers to function, or a fire hose to be used, a large bell located on the outside wall begins to ring. At night, in addition to this bell, another one located in the night watchman's office also rings in case of a fire. The sprinkler and fire alarm system was installed by the General Fire Extinguisher Company.

The shop is equipped with a modern shaving system collector. Each machine is furnished with a galvanized iron pipe through which the shavings are sucked to a

central pipe which passes out through the roof of the building. The shavings then pass into a hopper at the lower end of which is a spout. An old box car, in the roof of which two hatches have been cut, receives the shavings from the hopper. The hopper with the car in position, is shown in one of the illustrations.

Table I—Types of work handled during 1927, in the Maine Central cabinet shop at Waterville, Me.

No. of pieces	Description of part	Coats of paint
1	Baldwin cabinet	2
56	Engineers' seat boxes	1
16	Engineers' clothes boxes	1
96	Engineers' tool boxes	2
24	Locomotive fuse boxes	2
14	Emergency tool boxes	1
175	Locomotive water cooler boxes*	2
6	Engine pilots	1
48	Wooden steps for switching engines	1
24	Locomotive broom stands	1
48	Wood racks for metal flags*	2
4	Baggage car chests	2
36	Engineman's arm rests	..
24	Locomotive seat frames	..
12	Locomotive seat backs	..
60	Locomotive torch holders	2
18	Mail car stools	..
12	Mail car step ladders	..
4	Conductors' desks	..
6	Caboose iceboxes	
2	Work car refrigerators	..
101	Bridges for unloading freight	—
11	Portable milk racks for baggage trucks*	..
7	Bridges for unloading cattle	..

* A complete description of these items appear in the article.

The shop employs 26 men, of whom four are used in the locomotive shops for cab repairs. These men turn out all of the finished lumber, the bulk of the cabinet work and all of the pattern work for the system. On the first floor, where all the mill work is done, seven mill men, two helpers and one laborer handle the bulk of the 700,000 bd. ft. of lumber turned out yearly. Eight carpenters and cabinet makers are located on the second floor. They turn out all of the interior finish and outside sheathing for passenger cars. The items listed in Table I, indicate the quality and wide variety of work

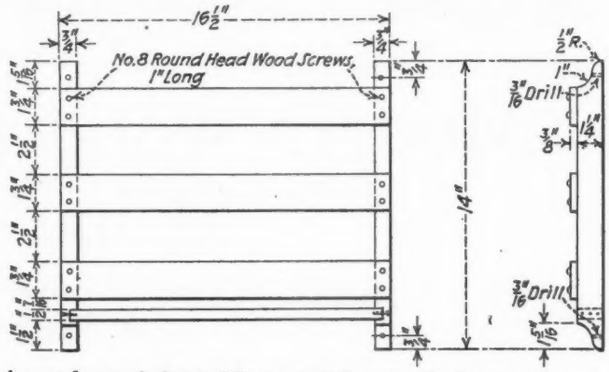
Four of the miscellaneous jobs made in the cabinet shop

handled each year in this shop. In addition to this list, all kinds of office furniture is repaired.

Miscellaneous items made in the cabinet shop

One of the illustrations shows four miscellaneous items made in the cabinet shop. The large empty paint barrels are sent to the cabinet shop where lids are made for them and they are given a coat of red paint. As the wood is thoroughly impregnated with oil, the barrels make splendid water containers for fire purposes. These barrels are distributed over the system for use in freight and passenger stations and other locations where other means for fighting a fire are not readily available.

Sitting on the floor, one on each side of the barrel, are two hand tool boxes for locomotive and car repairmen. These boxes are made so that the workmen can sit on them when it is convenient to do so. The top of the machinist's tool box has a hand hole cut in it so that the box can be easily carried about. The design of the car repairman's tool box is unique in that runners are provided on the bottom so that it may be pulled along over the floor or snow by inserting a rope through the hole in the front provided for this purpose. The costs of the machinist's and the car repairman's tool boxes

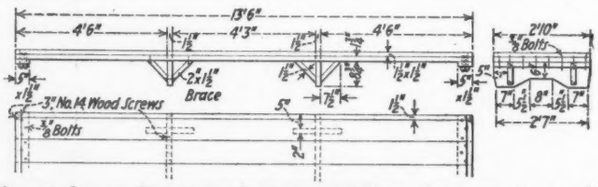


A wooden rack for holding metal flags in the locomotive cab

are $1.50 and $2.00, respectively. This includes a charge of 60 per cent for overhead.

A water cooler box used by the engine crews is shown sitting on top of the car repairman's tool box. This box, which is 8 in. wide, 13 in. deep and 15 in. long, is divided into two compartments separated by heavy mesh front end netting. The water container is placed in one compartment and the ice in the other. The boxes are given one coat of black varnish. They cost $1.64 complete. The road has found that the utilization of these boxes has effected a considerable saving in ice.

The Maine Central has discontinued the use of cloth locomotive inspection flags because they are easily destroyed and their consumption was abnormally high.



A wooden rack put on baggage truck to increase the loading capacity for milk cans

Metal flags are now used as they cannot be readily destroyed and can be repainted when they become dirty. The use of this type of flag made it necessary to devise a means of taking care of them in the locomotive cab. A wooden rack has been designed for this purpose. A drawing of the rack, which is made in the cabinet shop, is shown in one of the illustrations.

Portable milk racks for platforms are also made in the cabinet shop. These racks are of interest in that they increase the loading capacity for milk cans on baggage trucks. The sloping ends of the trucks limit the flat surface area on which to set milk cans. By using the rack shown in the drawing, the loading capacity is increased 50 per cent. When the truck is used for handling baggage, the rack is quickly lifted off.

The machine tool equipment

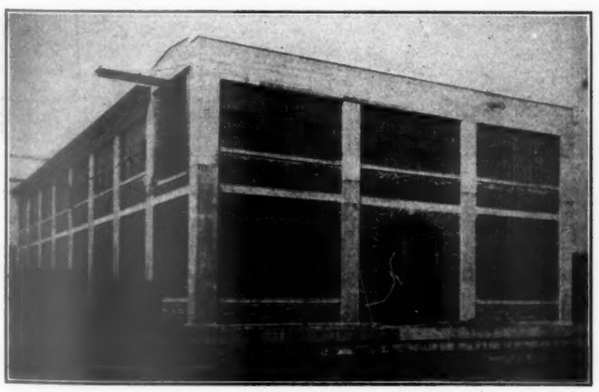
The shop is equipped with modern, motor driven, push

button controlled machine tools and shop equipment. A list of this equipment is shown in Table II. Safety guards have been provided for each machine. The fact that only one lost-time accident occurred in this shop during 1927 indicates their effectiveness. Table II lists the machines on each floor. The machines on the second floor were selected to produce molding, trim,

Most of the planing mill machinery is on the first floor

etc., necessary for passenger car and fine cabinet work. Each machine is supplied with a steel tool cabinet manufactured by the Durand Steel Locker Company.

The machines on the first floor were selected to size, cut and finish all kinds of lumber for freight and passenger car repair work. Several of these machines lend themselves to the utilization of form boxes and tools for speeding up production. One of the illustrations shows two tools used on the four-sided matcher to cut, in one operation, the two grooves in car roof ribs. One of the side heads in which these tools are used is also shown in the illustration as well as the two different types of car roof ribs grooved on these tools. An aver-



The shop is constructed of reinforced concrete, brick exterior panels and glass

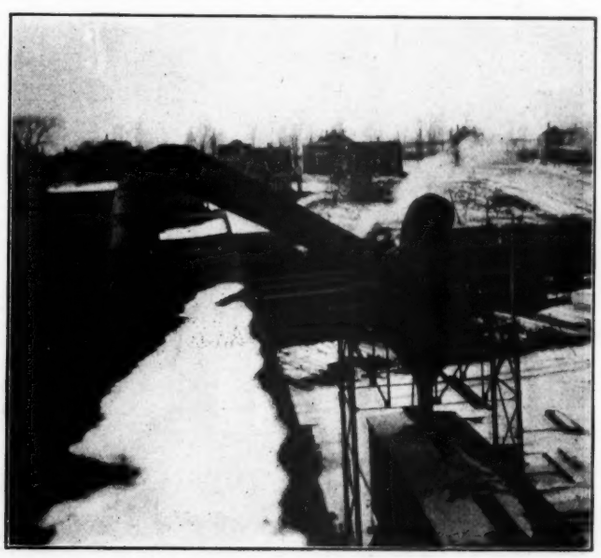
age of four hours is saved in grooving 500 ribs by the use of these tools.

Five different types of templets designed to increase production, are used on the band resaw which will handle heavy timbers up to 40 ft. in length. These templets are shown in one of the illustrations. Templet A is used to cut the bevel on box car ridge poles. The bevel is made in two cuts. The templet is reversed instead of the long timber and is adjustable for ridge poles of any size and bevel. Templet *B* is used for several

Table II—A list of the motor driven, push button controlled machines in the Maine Central wood mill at Waterville, Me.

No.	Name of machine	Builder
	Machines on second floor	
1	Horizontal post borer	Greenlee Bros. & Co.
2	Vertical post borers	Greenlee Bros. & Co.
2	Combination cutting off and rip saws	Oliver Machinery Co.
2	Buzz planers	Oliver Machinery Co.
1	Mortizer	Oliver Machinery Co.
1	Jig saw	Beach Manufacturing Co.
1	Wood turning lathe	Fay & Scott Co.
1	Edge trimmer	Oliver Machinery Co.
1	Vertical wood milling machine	Oliver Machinery Co.
1	Embossing machine	Oliver Machinery Co.
1	Vertical spindle disc sander	Oliver Machinery Co.
1	Single surfacer	P. B. Yates Machine Co.
1	Rip saw, 14 in.	J. A. Fay & Eagan Co.
1	Tenoner	Cordesman-Rechtin Co.
1	Four sided moulder	J. A. Fay & Eagan Co.
1	Universal wood trimmer	Oliver Machinery Co.
1	Band saw	J. A. Fay & Eagan Co.
1	Chain mortizer	New Britain Machine Co.
1	Double spindle shaper	Advance Machinery Co.
1	Sander with sliding table	P. B. Yates Machine Co.
	Machines on first floor	
1	Band resaw (Handle timbers 40 ft. long)	P. B. Yates Machine Co.
1	Swing cut-off saw	J. A. Fay & Eagan Co.
1	Rip saw, 4-ft. bed	J. A. Fay & Eagan Co.
1	Double surface grinder	Berlin Machine Co.
1	Four sided matcher	P. B. Yates Machine Co.
1	Cutting off saw, 36 in.	J. A. Fay & Eagan Co.
1	Vertical post borer	Greenlee Bros. & Co.
1	Double head mortiser	Greenlee Bros. & Co.
1	Reliance swing saw	.....
1	Combination cutting off and rip saw	Oliver Machinery Co.
1	Planer with 16-ft. carriage	.....
1	Buzz planer (Handles 14-in. by 16-ft. timbers)	C. B. Rogers & Co.
1	Band saw with a resaw attachment	Oliver Machinery Co.
1	Saw grinder	Hanchett Swage Works
1	Automatic knife grinder	Baldwin, Tuthill & Bolton Co.
	Miscellaneous equipment	
1	Double end floor grinder	Jas. Clark, Jr. Electric Co.
3	Wetmore electric glue pots	.....
1	18-in. vertical drill press (iron work)	.....

purposes. It is adjustable for width and is used for cutting a 15-deg. bevel on any size timber. At the left is shown a finished crosstie timber used on wood



The shavings are blown into a specially fitted box car for disposal

rack cars for hauling pulp wood. A finished grain strip is shown in the form box. Templet *C* is used for beveling the intermediate sills used on wooden hopper cars.

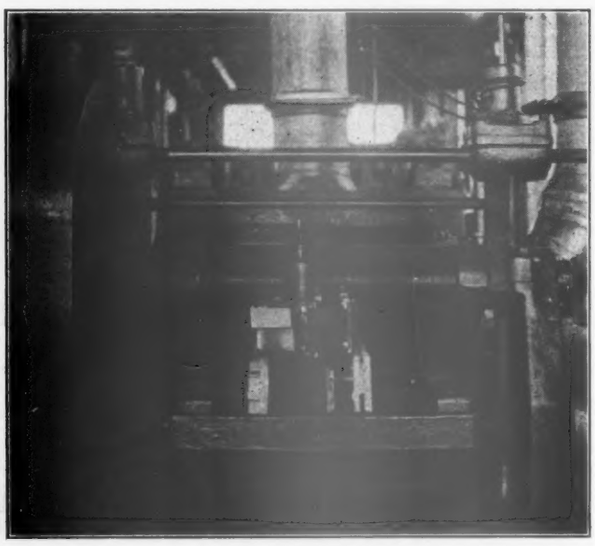
The templet is made in two parts, one of which is clamped to the table as shown. It is made in this manner so as to make it adjustable for any size of timber.

Two of the illustrations show how engine cabs are handled on the second floor of this shop. The cabs are lifted in and out of the shop by a two-ton electric trolley

Five templets used on the large band resaw machine located on the first floor

Templet *D* is used for cutting the grain strips used in the hopper of ballast cars.

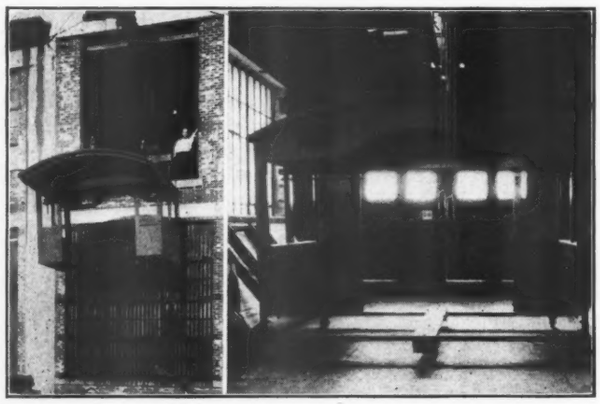
Templet *E* is used for cutting the nailing strips used on steel underframe box cars. By using a 3-in. by 7½-in. plank, two strips are cut at one time. When these strips were cut on a combination saw, it required two men four hours per truck load. By using this templet,



Special tools used on the four-side matcher for cutting the grooves in car roof ribs

the time per truck load has been reduced to 30 min. The guide bar on the table of the machine is used to line up each of these templets.

hoist which operates on a monorail that extends back to the middle of the cabinet shop. The cabs are moved



Left—The cabs are handled by a two-ton electric crane—Right: The frame used for moving cabs about the shop

about the shop on a frame platform which rolls on four roller bearing casters.

* * * *

ROLLWAY BEARINGS.—The Rollway Bearing Company, Syracuse, N. Y., has issued catalogue 4-A descriptive of its Wide Series and Utility type bearings. The following literature is also new: Bulletin No. 53—Self-alining pillow blocks equipped with adapter type bearings to fit standard commercial shafting; Bulletin No. 54—Various precision types of Rollway radial bearings; Bulletin No. 55—Self-alining pillow blocks equipped with standard Rollway bearings, and Bulletin No. 56—Large Rollway bearings in the recently adopted international sizes.

A 65-Ft. car for transporting steel

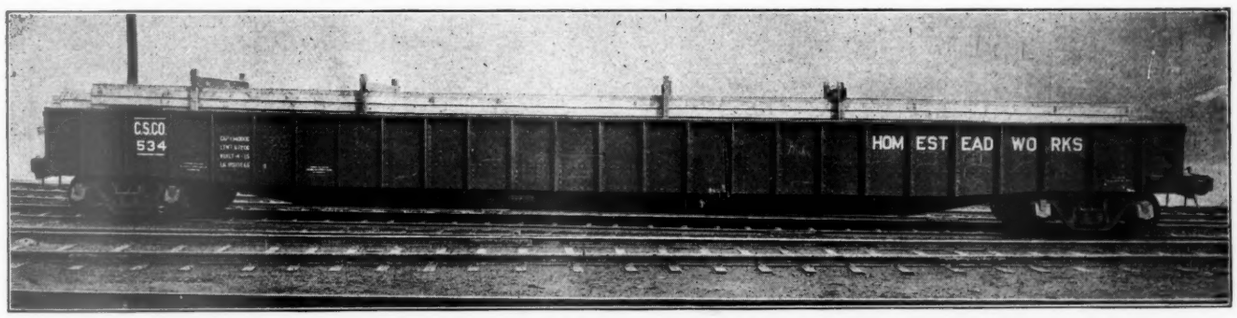
Carnegie Steel Company has 12 gondolas specially built for loading mill lengths—Inside width, 7 ft. 8⅞ in.—Capacity, 140,000 lb.

DURING the rebuilding of the structural mills at the Homestead (Pa.) Steel Works of the Carnegie Steel Company, a situation was encountered which caused considerable anxiety to the transportation department of that company and which presented a difficult problem. The management, in making plans for the rebuilding of these mills, decided that so far as was physically possible the operation of the mills would continue throughout the rebuilding program. To do this with any degree of efficiency, it was decided that the shipping department must give up a good portion of its facilities. With the loss of these facilities, it was found that it would be impossible for the shipping department to cut, load and ship the finished product of the mills from the point of production. To perform this work, it was decided to transport the long lengths of steel from the rolls to a new shipping yard, located a considerable distance south of the mills, which entailed a movement over the tracks of the Carnegie Steel Company and thence over the Union Railroad. It was then found that to do this would require literally thousands of double loads. Many ideas for handling this material economically were advanced, including a suggestion that the Carnegie Steel Company acquire a number of cars of such length as would permit the loading of the steel in one car, thereby eliminating, not only great expense for material and labor in blocking the loads, but saving considerable track room, which at that time was greatly needed. This suggestion was not favorably received at first, but later was approved, with the result that orders were placed with the Standard Steel Car Company for the building of 12 such cars. These cars are probably the longest ever built for commercial service and are dimensioned as follows:

Length inside	65 ft. 0 in.
Length over striking plates	68 ft. 9 in.
Width inside	7 ft. 8⅞ in.
Width over all	8 ft. 6 in.
Distance between truck centers	55 ft. 10 in.
Distance center of truck to inside face of knuckle	7 ft. 8½ in.
Height of sides	3 ft. 0 in.
Marked capacity	140,000 lb.
Average light weight	67,000 lb.

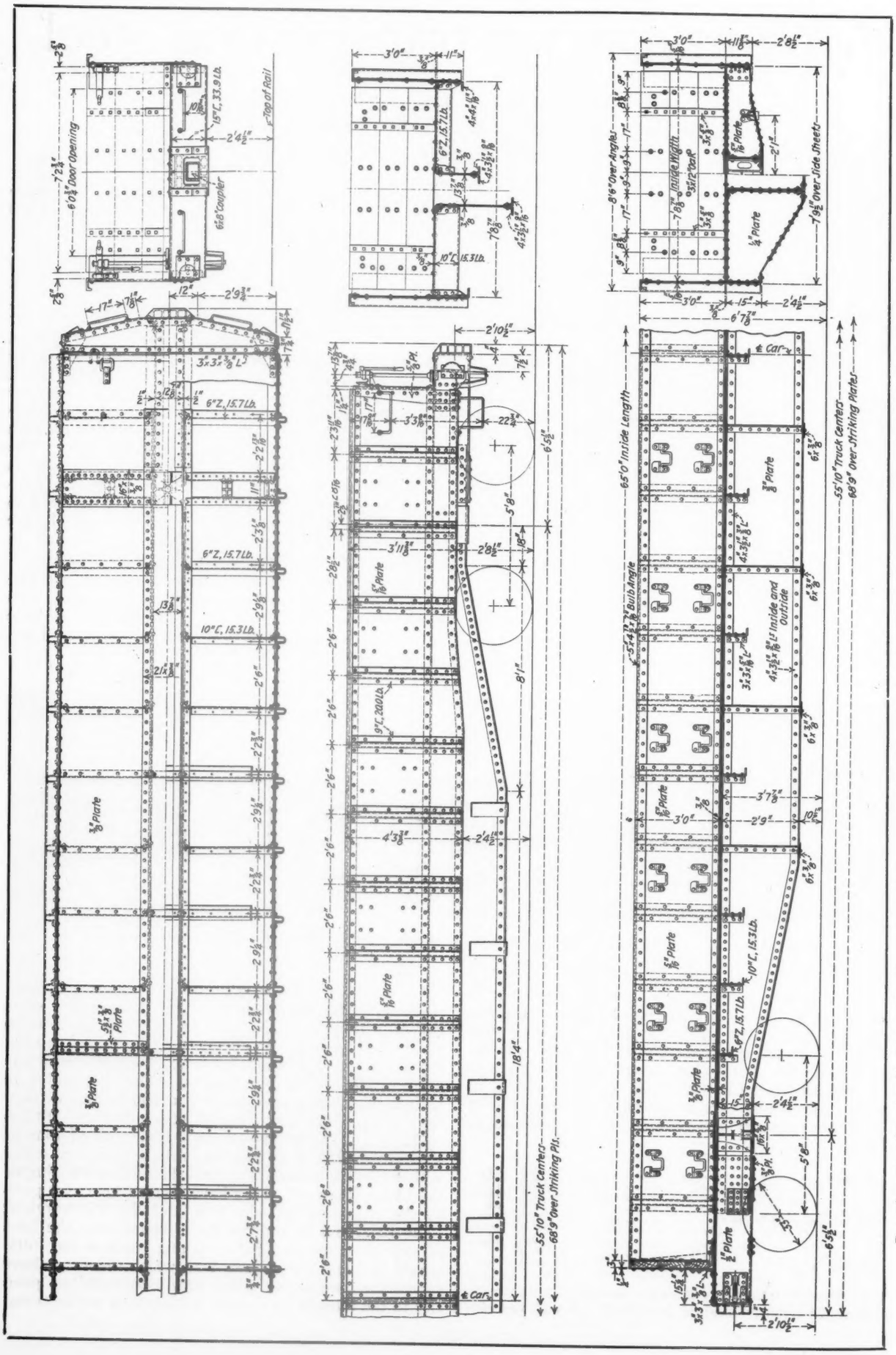
The 65-foot gondola car was designed to carry a uniformly distributed load of 140,000 lb. plus 10 per cent and to carry two-thirds of this load over 10 ft. of space at the center of the car with a fiber stress not over 15,000 lb. per square inch. The car is 65 ft. long inside and the height from the floor to the top of the car is 3 ft. 0 in. The center sills are of the fish belly type 33 in. deep with ⅜ in. webs, reinforced at the bottom with two 4-in. x 3½-in. x 9/16 angles and at the top with one 4-in. by 3½-in. by ⅜-in. angle. The side sills and the car sides are integral and of the girder type, made of 5/16 in. plate. The top side members are 5-in. by 4½-in. by 7/16-in. bulb angles and the side stakes formed from a 9-in., 20-lb. channel pressed U shape. The body bolster is box type of ample strength to meet the loading requirements and eight deep cross bearer diaphragms on each side transmit the load from the center to the sides. The floor of the car is made of ⅜-in. plate. The car is equipped with drop ends made of 3-in. white oak, reinforced with ¼-in. steel plate. The car is designed to operate on a 200 ft. radius curve and the end sills are tapered from the center sill to provide clearance in curving. The trucks are of standard dimensions.

It will be noted that the width of these cars is somewhat less than the ordinary mill type gondola. This width was decreased in order to give ample clearance in rounding short curves. The cars were delivered and put into service in April, 1925.



A side view of a 65-ft. gondola developed by the Carnegie Steel Company for loading mill lengths

Upon delivery, there still existed considerable skepticism as to the ability of these cars to negotiate short curves within the mills, and there were fears as to their clearing ability in the mill yards. After almost three years of operation, however, their efficiency has proved to be beyond expectations. While the cars were built to negotiate curves having a 200-ft. radius, they have successfully operated over curves having a radius of 175 ft. The cars have hauled thousands of tons of steel since 1925 and have traveled thousands of miles within the Homestead Steel Works and on the line of the Union Railroad. They have also traveled over parts of the Bessemer & Lake Erie and the Pittsburgh & Lake Erie, and in addition have moved over the lines of several of the terminal switching roads in the Pittsburgh district. The success with which these cars have served the purpose for which they were built has given rise to the thought of further testing them out in actual



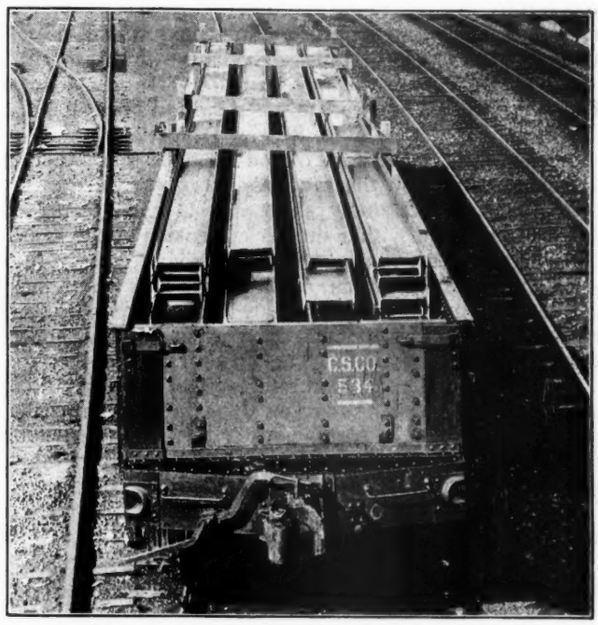
Drawing showing details of construction of the 65-ft. gondola designed by the Carnegie Steel Company and built by the Standard Steel Car Company

trunk line movement with a view of determining their possibilities in general service.

Steel manufacturers are being confronted each year with demands from their customers for shipment of increased lengths of their products. Stock lengths of 60 to 65 ft. are now generally common to the majority of fabricating shops. It is estimated that the 65-ft. type of car will handle probably 80 per cent of the long lengths of steel now being ordered from the various steel manufacturers. It has therefore been pointed out that should these cars be found capable of service over the trunk lines, a considerable saving would ensue to both the carriers and the shippers. It is not expected nor is it advocated at the present time that the carriers should provide themselves with this long type of car to replace the standard mill type gondola car in entirety. The ordinary mill gondola with drop ends, having inside length of from 42 to 50 ft. serves admirably for general purposes and for the handling of shorter lengths of steel.

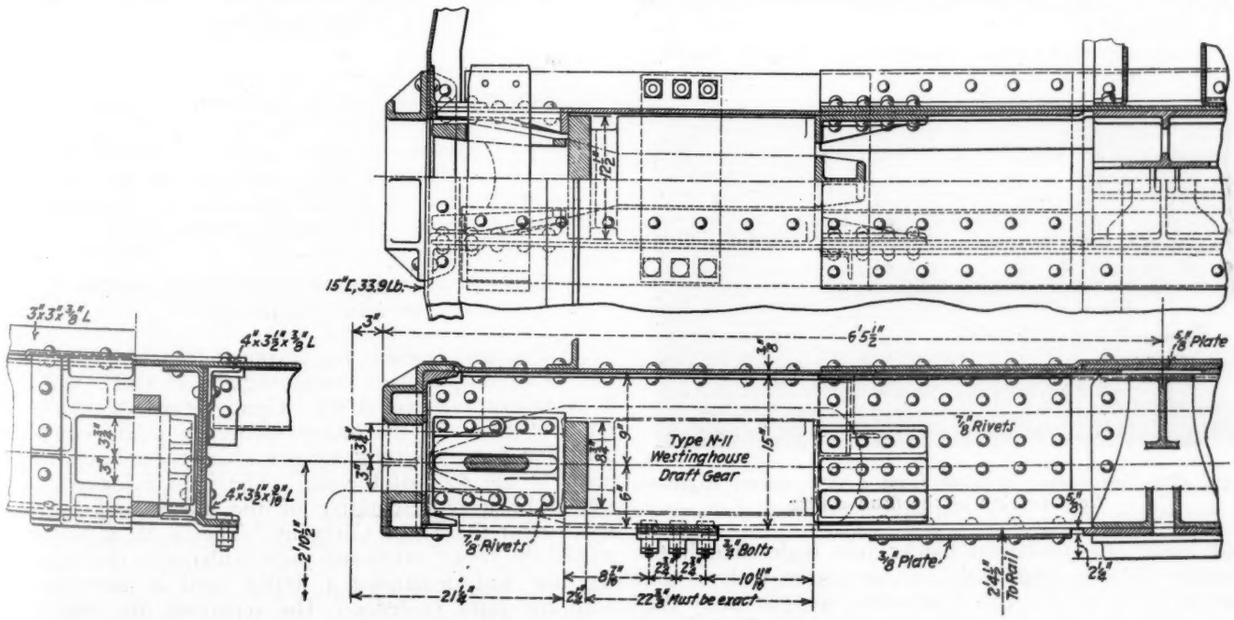
The use of the longer cars should result in operating economies

The cost of the 65-ft. car, it is estimated, will be slightly over 50 per cent of the cost of two ordinary gondola cars. Maintenance and depreciation on one 65-ft. car will of course be considerably less than the same charges against two of the mill type cars now used for making double loads. Since the track space taken by the 65-ft. car will be 30 per cent less than that of the double load, yard capacities will be increased and train lengths decreased accordingly. In shipping steel in double loads, the possibilities of danger are greatly enhanced, which possibilities will be considerably lessened by the shipping of the same materials in single cars and would therefore result in a saving to the carriers. In the elimination of dunnage by using the single car, the carriers will haul less deadweight per ton of revenue traffic moved. The elimination of dunnage will also help partially to solve the "dirty car" problem, which recently has been the subject of much discussion between the carriers and shippers. Train resistance will be reduced due to the fact that twin shipments particularly flexible materials which rest heavily on sliders and haul heavily on curves owing to the lateral movement of the lading when rounding curves, would be reduced by using the single car instead of the double load. There is also a greater element of safety in a single load than in a double load.



On account of its length, the 65-ft. gondola is narrower than the ordinary car of this type

The greatest saving to steel shippers will of course be found in the elimination of the expense of blocking the double load. To one not accustomed to shipping double loads this may seem trivial, but to the producers who ship considerable quantities of their product in such a manner it is not an insignificant item. The elimination of the double load will also enable shippers to load cars more promptly. Since the one car will take up 30 per cent less space than the two cars now required for a double load, the loading track capacity in



Detail drawing of the draft gear

the steel mills will be considerably increased as desired.

Recently a party of 50 railroad and industrial transportation officers had the opportunity of inspecting these cars at Homestead Steel Works and of witnessing a demonstration of their handling in actual service. Curves with a radius of from 150 ft. to 220 ft. were successfully negotiated by the 65-ft. car. However on the 150-ft. curve, an empty gondola next to the 65-ft. car was lifted from the rails. The cause of this derailment was ascribed to the fact that the 65-ft. car, which of course was an experiment when built, was constructed with a distance of 7 ft. 8½ in. from the center of the truck to the inside face of the knuckle, thereby creating an overhang in the car body too great to operate successfully on extremely short curves when coupled to cars constructed with a shorter dimension at the same point, the car with the long body overhang pulling the car of shorter construction off the track. This is a defect in construction which was revealed only by experience and which is capable of correction when building additional cars of this length. The underframe of the 65-ft. cars now in use at Homestead Steel Works has a track clearance considerably less than the standard cars now operating on the trunk lines today. Investigation of this feature has been made and has resulted in finding that the cars will not clear the apex of all humps of the various trunk line yards. This objectionable feature can be readily eliminated in future construction.

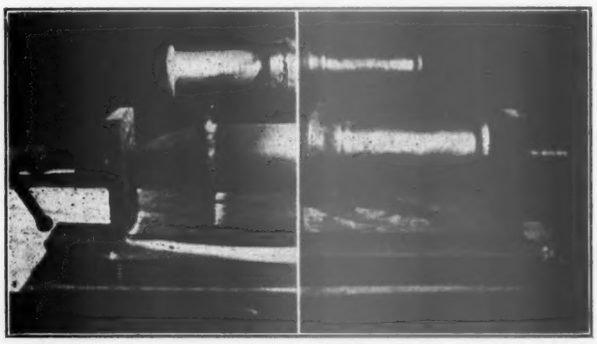
Within the near future, the Carnegie Steel Company will ship test loads of these cars from their various plants on the Union Railroad to plants of customers within the Pittsburgh district. These movements will give the carriers and consignees an opportunity to become acquainted with the possibilities of the car. It has already been demonstrated that the cars will ride around curves over which it is impossible to handle double loads in drop-end gondolas loaded in accordance with the present car loading rules of the A. R. A.

Welding collars on car axles

By I. W. Eger

System welding supervisor, D. & R. G. W., Denver, Col.

AFTER trying numerous ways to expedite the handling of axles to be welded, we found that the track shown in the illustration is efficient for this work. This supply track is built of short lengths of



Left—The live center is made from a vise screw; Right—Construction of the dead center

old track rail placed on blocks just high enough to receive the axle from dolly cars or trucks without the use of an air hoist. The dead center used to carry the axle while being welded is made of 6-in. by 2-in. channel iron with a piece of 1-in. by 6-in. iron bent to a 45-deg. angle and welded to one end of the track. A dead center is fit in this support just high enough to receive the axle and raise it off the track when the live center is tightened on the opposite end. As shown in the illustration, the live center is made of an old vise screw

The axles are rolled along on two rails

that has been shortened and a center point ground on the end. The nut is made of 4-in. round brass with square threads cut to receive the screw. The nut is welded to the stand with a phospherous bronze electrode. A permanent wire connection is made at the dead center end of the device. This permanent connection not only saves at least ten minutes in changing connections, but also eliminates any possibility of the current arcing across through the rust to the axle and spotting the metal, which causes some hazard of breaking. The welding, of course, is limited to the collar.

Decisions of the Arbitration Committee

(*The Arbitration Committee of the A. R. A. Mechanical Division is called upon to render decisions on a large number of questions and controversies which are submitted from time to time. As these matters are of interest not only to railroad officers but also to car inspectors and others, the Railway Mechanical Engineer will print abstracts of decisions as rendered.*)

Car owner's signature sufficient under certain conditions

On August 12, 1926, the Terminal Railroad Association of St. Louis made certain repairs to Gulf, Mobile & Northern car No. 4789. Upon return of the car on September 22, the owner secured a joint evidence card for certain wrong repairs claimed to have been made to the roof of the car. The joint evidence was signed by a representative of the owner and an inspector for the Texas Company. The G. M. & N. submitted the repair cards and joint evidence to the repairing line and demanded a defect card in accordance with the joint evidence. The repairing line declined to honor the joint evidence card on the ground that the

joint evidence was invalid and did not comply with the provision of A.R.A. Rule 12, which requires that joint evidence must be issued by a joint inspector or by two inspectors, one representing the owner of the car and the other representing a railroad company that is a subscriber to the A.R.A. Interchange Rules. The Texas Company is a private car owner and not a railroad company.

The Arbitration Committee stated that "The joint evidence furnished in this case meets the requirements of Rule 12, second paragraph. The contention of the Terminal Railroad Company of St. Louis is not sustained."—*Case No. 1540—Gulf, Mobile & Northern vs. Terminal Railroad Association of St. Louis.*

Another case of Rule 32

On December 16, 1926, a Pere Marquette locomotive was pushing a cut of 16 cars on a repair track when the knuckle broke on the fifth car from the head end, allowing the cars that broke loose to strike standing cars on the lead, with the result that extensive damages were done to Chicago, St. Paul, Minneapolis & Omaha car No. 27134. The car was reported to the owner as subject to A.R.A. Rules 44 and 120 with a joint inspection certificate listing the defects. The handling line contended that as rider protection had been provided and that no cars had been derailed, cornered, side swiped or otherwise damaged, as listed under Rule 32, the handling line could not be held responsible. The owner contended that the car was not damaged through ordinary switching, but was actually damaged by collision due to the train parting and failure to regulate the speed of the cars by the use of hand or air brakes when the cut broke loose.

The Arbitration Company held the handling line responsible as per Rule 32, Section (d).—*Case No. 1541—Pere Marquette vs. Chicago, St. Paul, Minneapolis & Omaha.*

Misinterpreted signals claimed to have caused damage to car

On September 9, 1924, Louisville & Nashville car No. 91218 was seriously damaged on the lines of the Missouri Pacific. During the month of December, the M. P. rendered a repair bill amounting to $311.14. The L. & N. contended that the damage to the car came under Rule 32, Paragraph (d), Item 2, therefore making the damage the handling line's responsibility, claiming that the engineman did not see the signals given by the trainmen. The M. P. did not agree with this statement and contended that the car had not been unfairly handled within the intent of Rule 32, or was there any condition to warrant the owner's claim of a misinterpreted signal.

The decision of the Committee was to the effect that the car had not been damaged under any of the conditions of Rule 32 and therefore the contention of the Louisville & Nashville was not sustained.—*Case No. 1542—Louisville & Nashville vs. Missouri Pacific.*

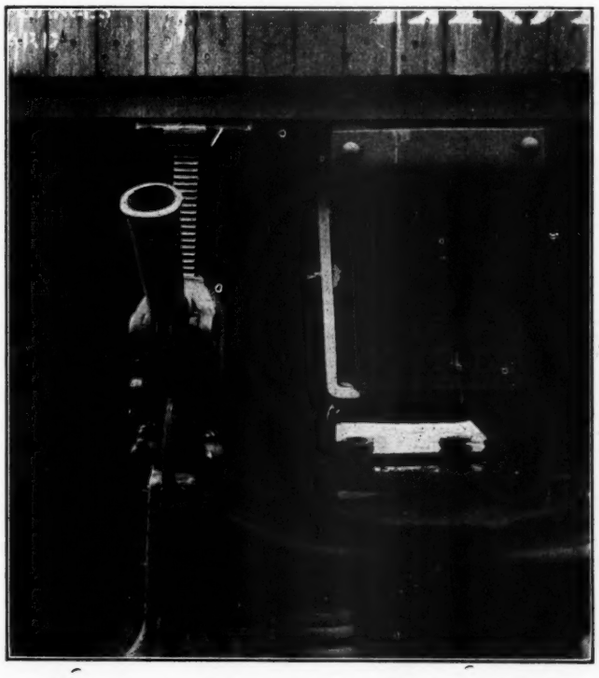
Unfair usage claimed as cause of cracked wheel plates

On May 9, 1925, the Fort Worth & Denver City removed four pairs of wheels from PGX car No. 1310, on account of cracked plates and treads, applying new wheels and rendering a bill for the difference in value of the new wheels applied and the scrap wheels removed. The Proctor & Gamble Transportation Company objected to the charge, claiming that the defects were the handling line's responsibility as there was a possibility of unfair usage by a previous carrier, rather than faulty castings as contended by the Ft. W. & D. C.

The Arbitration Committee held the owner responsible under Rule 78.—*Case No. 1543—Fort Worth & Denver City vs. Proctor & Gamble Transportation Company.*

A handy device for removing car springs

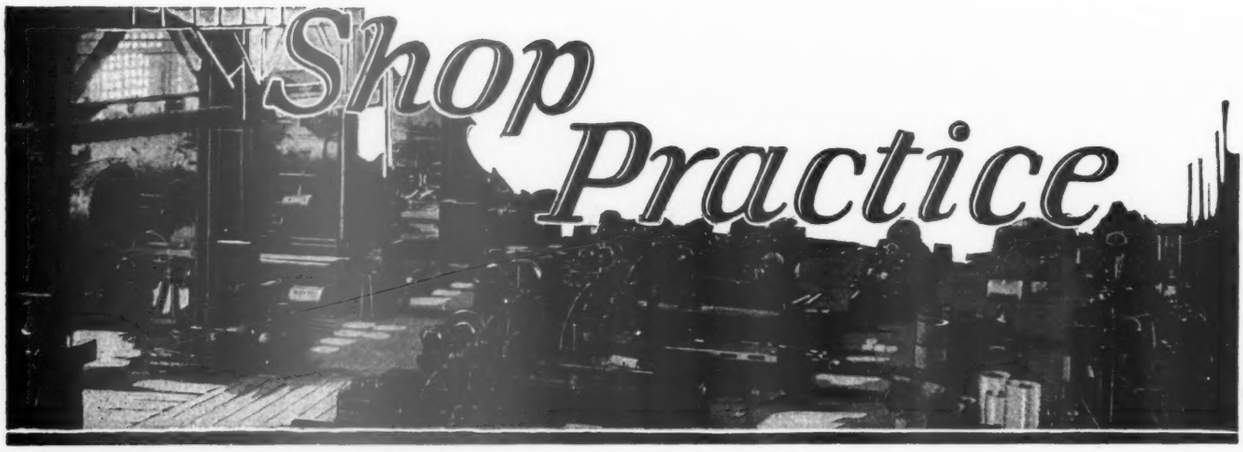
ORDINARILY, it is a rather difficult job to remove car springs owing to the fact that the weight of the truck bolster has to be removed from the springs after the car has been jacked up. This difficulty has been overcome at the West Springfield, Mass., car shops



Two hooks are holding up the truck bolster while the springs are being renewed

of the Boston & Albany by the utilization of a hook, one end of which fastens over the body bolster, the other end hooking under the truck bolster. One hook is used on each side of the car. The illustration shows how the hook functions after the car has been jacked up and the springs removed. For all freight cars other than flat cars the hook measures 23 in. inside of the jaws, and for flat cars it measures 18 in. The hooks are made of ⅞-in. square stock. They not only expedite the renewal of springs, but also have prevented many injuries which occurred with a former method of holding up the truck bolster.

ELECTRIC HOISTS.—One of a series of material handling equipment bulletins being prepared and published by the Chisholm-Moore Manufacturing Company, Cleveland, Ohio, is now ready for distribution. Starting with a short treatise on the importance of electric hoists in industry, the new catalogue, No. 31, covers the various types of hoists, illustrates their use, describes their operation and care and gives diagrams and tables of clearances, dimensions and other data.



Repairing tubes at N. Y., N. H. & H. Readville shops

General layout for continuous production—Output increased and tube failures and shop force reduced

THE New York, New Haven & Hartford in keeping with the general scheme of modernizing the repair facilities at Readville, Mass., has relocated and rebuilt the flue shop at that point. At Readville is the main repair shops for the New Haven system. An average of 40 heavy class repairs are turned out at these shops every 25-day period, and approximately 5,500 small tubes and 400 superheater flues are repaired during the same period.

Until about a year ago this shop was equipped to safe-end the flues using oil furnaces for heating. This method was not entirely satisfactory for several reasons. First, owing to the excessive heat of the furnaces, the labor turnover was high. Second, the percentage of tube failures while undergoing the hydrostatic test was excessively high. Third it was felt that the cost per tube was considerably higher than it should be.

It was decided to change from oil furnace welding methods to the electric welding method. This necessitated a complete change of flue shop machinery. In addition, the shop was moved to the lower end of the main shop. This was done for two reasons: First, to provide additional floor space, and second, to be near the rattler and the new tube storage racks shown in one of the illustrations.

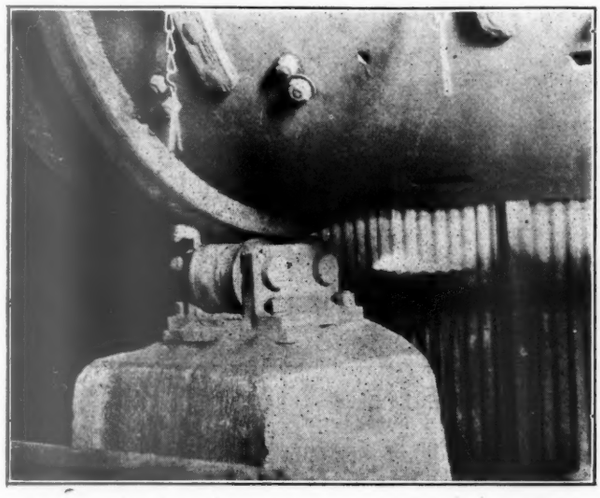
A general view of the New Haven flue shop at Readville showing how the flues roll from station to station

As may be seen from the general view of the shop

shown in one of the illustrations, the shop is laid out so that the tubes as they come from the rattler, pass from one operation to the next without the necessity of back-tracking.

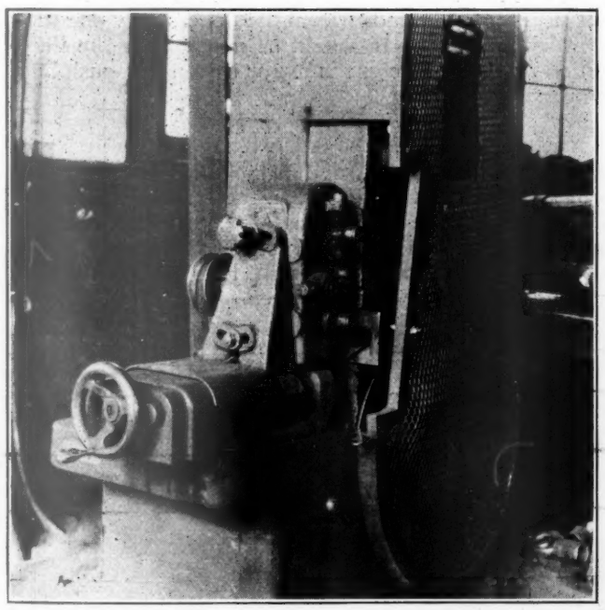
Equipment and method of handling the tubes

The rattler is located outside of the end of the shop



The third pier that supports the drum at the middle

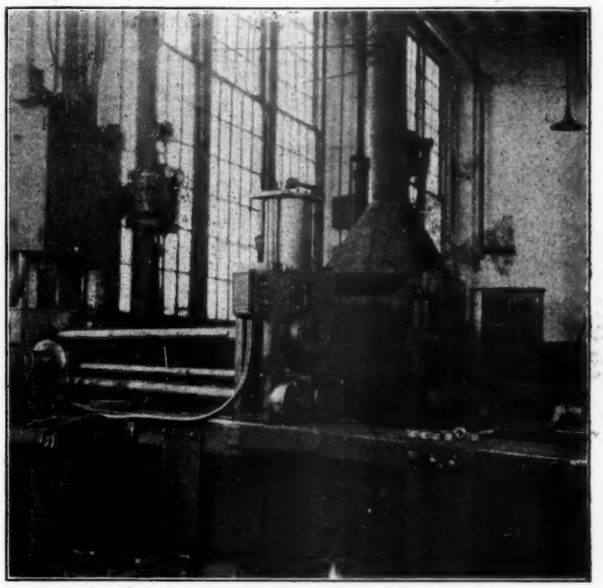
where the tubes begin to pass through the shop for repairs. The rattler is housed in a fireproof building resting on a concrete foundation and constructed of cor-



The flue polishing machine

rugated galvanized sheets fastened to a framework of angle irons welded together. The building is served by two, 10-ton Sheppard electric mono-rail hoists. The rails extend outside of the building a sufficient distance to make it possible to pick up a set of tubes for placing in the charging cradle located alongside of the rattler.

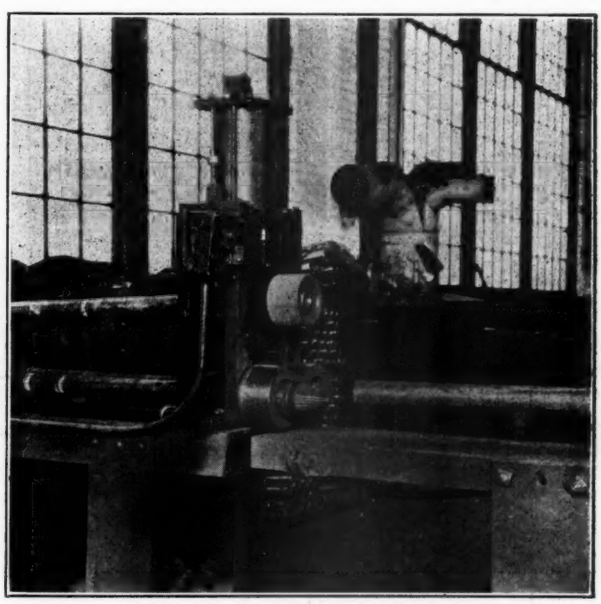
The drum of the rattler, which is driven by a 25-hp. motor, rests on three concrete piers. As shown in one of the illustrations, the third pier supports the drum at the middle to prevent sagging and to prolong the life of the two end trunions. A locomotive tire, the tread of which has been cut vee-shaped, has been welded around the drum. This tire revolves in two vee-shaped rollers.



The welded safe end is rolled in this machine

The fact that one set of rollers has been worn out since the rattler has been put into operation indicates the amount of sag that occurs at the middle of the rattler.

Four tee bars are equally spaced around the inside circumference of the drum, parallel to the center line.



After the flues come from the polisher they are reamed on this machine

Holes have been drilled 12 in. apart in these four bars for the purpose of adjusting the end plates. The mill will handle tubes from 10 ft. to 19 ft. 6 in. in length The tubes are lifted by the electric hoists into a cradle which automatically trips, allowing the tubes to roll into

the drum. The tubes remain in the rattler from three to six hours depending on their size and condition.

The tubes are then taken to the shop and placed at the head end of the frame work on which they are passed from one operation to the other. This frame is made from angle irons, channels and other material reclaimed from dismantled cars. Concrete piers on which the frame rests, have been set in the floor. The angle irons on which the tubes roll, are sloped so that the tubes will travel from one position to the next, where they come in contact with two stops. Located in front of each machine is a channel on which are two sets of rollers in which the tubes revolve during the repair operation. At the end of the frame, the tubes roll off into a cradle ready either for delivery to a locomotive or to the storage rack located near the rattler. The fireproof storage rack is divided into 27 bins which are located on an angle for easy handling of the flues. A concrete roadway extends along the front of the bins.

A fire proof flue shed designed for easy handling of the flues

The electric flue welder

Passing a tube through the shop

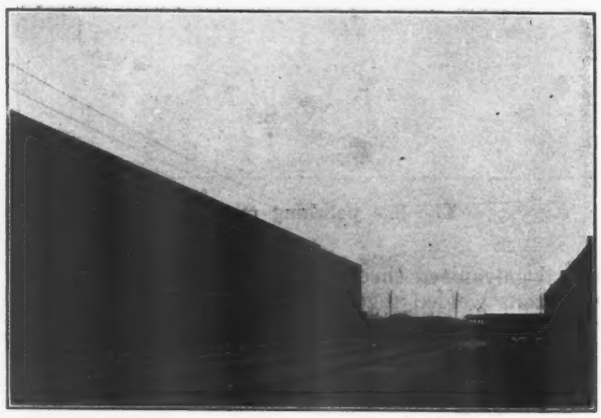
The first operation in the shop is to pass the ends of the tubes through a polisher built by the Production Machine Company. Here, the ends of the tubes are prepared for the electric welding machine. The tubes then pass to the next machine where the inside of the ends are reamed. This machine can also be used for polishing the ends. Attached to the end of the top spindle of this machine is a knurled roller which is forced on to the tube by air pressure. The tubes next pass to the electric welder built by the Winfield Electric & Machine Company. The machine welds on the safe ends from 6 in. to 60 in. long, cut from new tubes. It requires one minute for each tube to complete the electric weld and roll it in the machine located next to the welder. Two men are employed on this operation. The tubes then pass to the swedging machines which are served by an oil furnace. Two swedging machines, one located at each side of the furnace are used to swedge tubes in size from 2 in. to 5½ in. in diameter. The tubes then pass to the cutting-off machine.

The last operation is the application of the hydrostatic test. Owing to the excellent results obtained in the safe ending and swedging operations, the hydrostatic test has been discontinued. The records show that it is necessary to remove from the boilers only one tube in every thousand. It should be noted from the illustration that each machine is motor driven and push button controlled.

The results obtained

As a result in this change in the shop, the force has been reduced from 15 to 8 men, the labor turnover has been reduced to practically nothing, the percentage of tube failures has been reduced to a minimum and the cost per tube has been materially reduced, with a corresponding increase in production.

* * * *



Transfer table between the D. L. & W. car and locomotive shops at Kingsland, N. J.

Grand Trunk Western has fireless engine house in Chicago

Installation of direct steaming has resulted in smoke elimination and operating economies

THE elimination of smoke at engine terminals in thickly populated districts is a problem which is demanding considerable attention at the present time. A recent installation of direct steaming equipment at the Elsdon engine terminal of the Grand Trunk Western, located within the limits of the city of Chicago has resulted in the almost complete elimination of smoke and has actually created a fireless enginehouse.

The Elsdon terminal handles passenger, freight and yard power and despatches an average of about 35 locomotives each 24 hours. The enginehouse has 23 stalls and since it was originally built about 1885, has had the stalls remodeled from time to time to accommodate modern power. In the conversion to operation with direct steaming the smoke jacks have been omitted.

Under present operating methods the fires on all locomotives are dumped at the inbound ash pit before the engines are taken into the house. Unless a boiler is to be blown down for washout or repairs the locomotive is immediately placed on the line and the steam pressure held at 150 lb. or more until called for service when it is moved out of the house under this pressure and fired up outside. It has been found; after several months experimenting, that when the engines leave the house under 150 lb. pressure or more, they can be fired up with but a very slight trace of smoke.

The sizes of the locomotives handled at this terminal range from the 0-8-0 type switchers, the boilers of which hold about 1,800 gal. of water to the second gage, to the 4-8-4 type passenger locomotives which take over 4,000 gal. to fill to the second gage. The average Mikado type locomotive handled at Elsdon terminal takes about 2,500 gal. of water to fill the boiler to the second gage. On an average only about three locomotives are blown down, refilled or washed out each day, the rest being held under steam.

System indicates unexpected advantages

Contrary to the general belief, the system has expedited the despatching of locomotives and has effected economies which were not anticipated. Owing to the elimination of smoke, gases, noise and steam from popping safety valves, the roar of the old type blowers and the smoke and soot in cabs, the working conditions for the enginehouse employee have been improved so that they are comparable with those of the back shop. This has resulted in the removal of many conditions that were objectionable from the employee's standpoint and a decided improvement in the appearance and attitude of the men is noticeable. Some of the older employees stated that they had never expected to work in an enginehouse under such pleasant conditions.

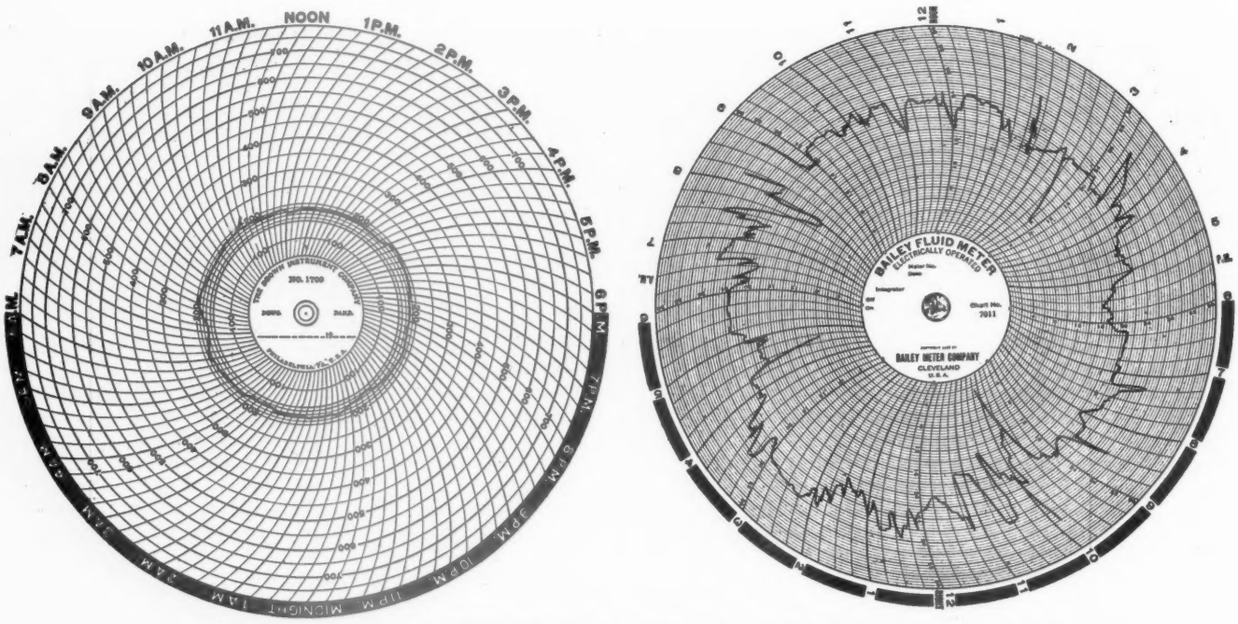
Probably the most important tangible saving effected has been that of locomotive fuel. It is, however, worth while noting that while the enginehouse is equipped with an indirect heating system it has not been used so far

Locomotive at the fire lighting station

Ten minutes later, all ready to go

this winter. Although the outside temperature has been below zero on several occasions the interior of the house is said to have been comfortably warm at all times. This condition is due to the fact that there are from 15 to 18 engines under steam in the house all the time and the removal of the smoke jacks makes it possible to retain the heat in the house.

Chicago. It is known as the direct steaming system whereby the locomotives are supplied with steam from a stationary boiler plant through the medium of flexible connections at each stall. After leaving the cinder pit, where the fires are dumped, the locomotive proceeds under its own steam to the enginehouse stall where it is immediately connected to the power plant supply through

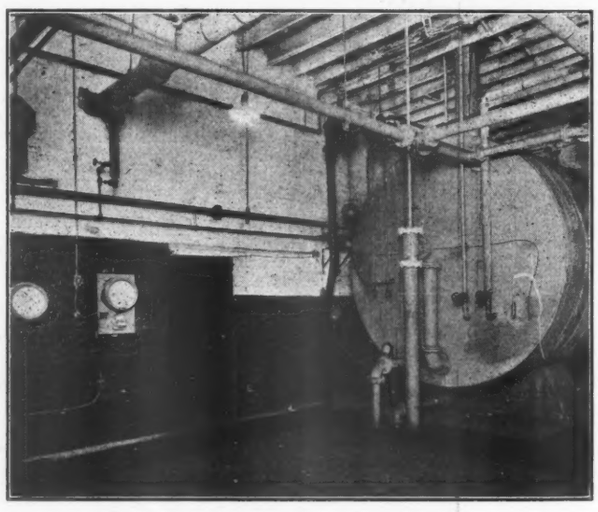


Typical charts showing the temperature of the filling water and thousands of pounds of feedwater per hour to the stationary boilers

In order to determine the savings effected by the installation of the direct steaming equipment a series of tests were made to obtain the cost of handling power in the old way. So many variable factors enter in that it is not desirable to attempt to give specific figures relating to these tests. A summary of the tests will give an idea of the possibilities of future operation. To obtain the cost of holding locomotives under steam, as for emergency service, tests were conducted with a U.S.R.A. light Mikado, the engine being fired by hand and held at approximately 150 lb. steam pressure for 24 hours. The results indicated an average fuel consumption of 375 lb. of coal an hour. To determine the amount of coal required to fire up a similar locomotive from fill-up water at a temperature of 125 deg. F. to 150 lb. gage pressure, test results indicated that 2,855 lb. of coal were required. Assuming that the locomotive was in the house for eight hours, the coal required per hour would be 356.9 lb. To handle the same type of locomotive with direct steaming would require 112.5 lb. of coal an hour, indicating a saving under the direct steaming system of about two-thirds of the locomotive fuel used in the old style engine terminal. It appears from results obtained so far that with the direct steaming of locomotives there should be an extension of the life of the enginehouse itself due to the elimination of smoke and gases with a resultant lower cost of building maintainance, as no smoke jacks are required.

Description of the installation

The system was designed and licensed by the Railway Engineering Equipment Company, Chicago, in co-operation with the railroad company's engineers and installed by the National Boiler Washing Company, contractors, an extra heavy 2 in. flexible copper hose and a ½-in. steam line which holds the pressure to within a few pounds of that of the stationary plant. After boiler and

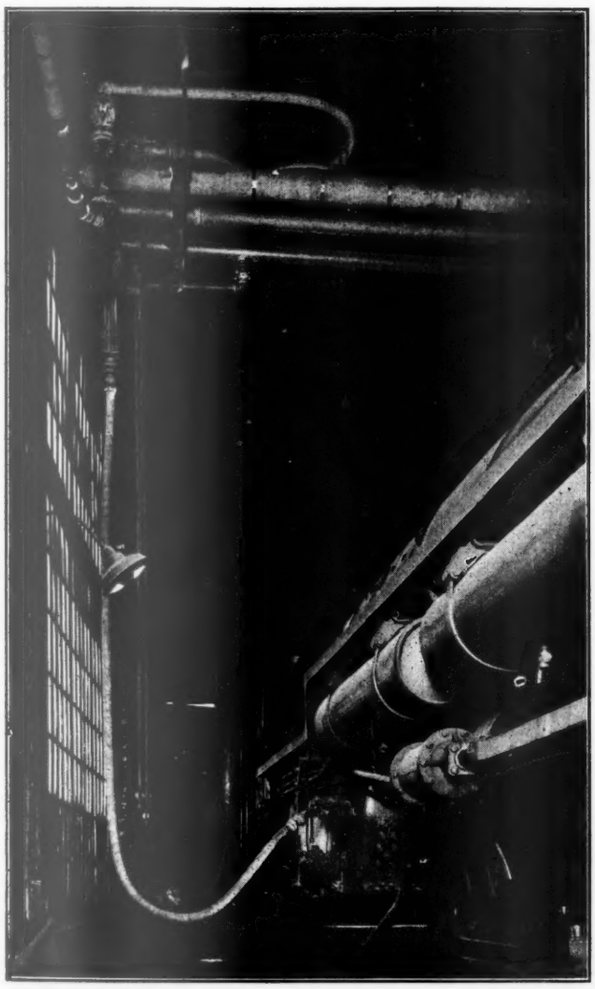


The hot water storage tank in the pump room

fire box inspection, 90 scoops of coal are distributed evenly over the grates. All operations, such as testing air pumps, headlight, generator, turbines, and injectors, can be made under power plant pressure and with comfort to the workmen.

If boiler work is required the boiler is blown down in

a manner similar to the blowoff for a hot-water washing system. The latent heat and steam are used to heat the fill-up water. When the boiler work is finished the boiler is filled with steam for a few minutes, to equalize the temperature, after which water at 180 deg. F. and stationary boiler plant steam are admitted at the same time, resulting in from 10 to 15 lb. pressure in the boiler by the time the water appears at the bottom of the water column. The water is then turned off and steam alone allowed to build up the pressure. This operation of



Direct steaming connection to the locomotive and overhead piping in the enginehouse

filling and steaming requires approximately 30 minutes, depending entirely on the steam available and the temperature of the fill-up water. After the pressure has been raised to the desired point the large 2-in. steam boosting line is closed and the ½-in. steam line turned on for holding the engine under steam until despatched. All of the above operations are accomplished with but one flexible copper pipe connection to the blow-off cock, which can be attached very quickly. The control valves are mounted on overhead pipe lines and are operated by extension handles within easy reach of the floor.

Prior to despatching the locomotive the 2-in. booster line is opened while the air is being pumped up, assuring a full head of steam and air for the movement to the fire-up track.

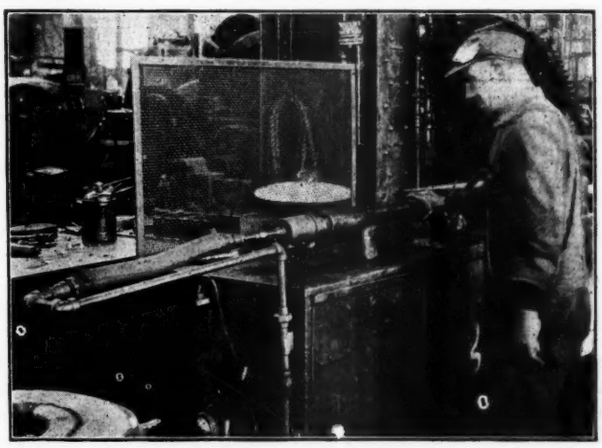
After leaving the enginehouse the locomotive is delivered to the fire-up track. Here fuel oil and air stations are installed to which fire-up torches are attached. The torch is of the syphon type, the oil pressure being only a few ounces, with air at approximately 100-lb. pressure. Five or six minutes are usually required to ignite the fuel bed, after which the locomotive is ready for movement to the train yard. The time intervening between firing and coupling on to the train has been found sufficient to give the fireman plenty of time to have the fire in good condition for handling a train. The success of despatching depends largely upon the steam pressure on the boiler at the time of firing. Low steam pressures result in poorly ignited fires and considerable smoke.

The power plant

Because the power plant is the heart of the direct steaming system, it was necessary to install high pressure boilers. The plant consists of two 300-hp. 200-lb. bent tube boilers set in one battery. The boilers are fired by chain grate chokers, a feature of the stokers being individual engine drive with two speeds through gear reduction, eliminating the old style line shaft. Coal is dumped on an elevated structure and fed automatically to a chain bucket conveyor which feeds independent hoppers for each boiler. From storage hoppers the coal is fed by gravity to the stokers. The ashes are dumped into a pit under the stokers and removed by a steam ash ejector into a hopper feeding directly into cars outside of the plant.

A method of softening the grease for filling cellars

IT is always a slow and tedious job to work cold grease into a driving or engine truck box cellar and have a smooth surface for the journal bearing. The

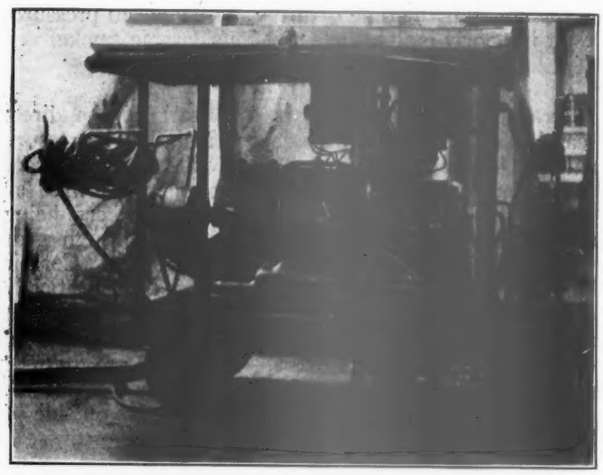


The hot roller softens the grease as it is worked into the cellar

device shown in the illustration is a steam heated roller that has been developed for this kind of work. The roller can be made of either copper or brass, and is equipped with insulated hand holds for the protection of the workman. The hose and a ball joint provide a flexible coupling to the steam line. If necessary, a reducing valve can be placed in the steam line in a convenient location, to reduce the pressure of the steam going into the roller.

Improvements made in electric welding machine

IT was found at the Denver shops of the Denver & Salt Lake that the life of electric welding machines could be prolonged considerably by mounting the rear end on spring shock absorbers, as shown in the illustration. This arrangement takes up the shock when the operator



Three ingenious improvements add to the life and adaptability of this welding machine

is drawing an arc, as well as when the machine is being moved over rough ground.

A frame for the coil spring is built up by welding together small pieces of straps and angles. A sheet metal top, with canvas sides which may be rolled down when the machine is not in use, is also a valuable addition to the machine. This protects it from the weather when working outside. Long hooks, welded to the frame, support the extension lines when the machine is not in use.

Two all metal racks for holding piston rods and boring bars

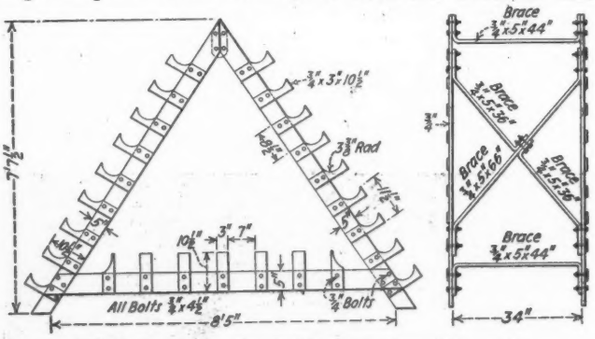
By H. H. Henson

Machine shop foreman, Southern, Chattanooga, Tenn.

TWO convenient all-metal racks for holding piston rods and boring bars are shown in the illustrations. The purpose of the piston rod rack is to have in a convenient location an adequate supply of piston rods for the engine house and the erecting shop. New rods are cut off the proper length for the different classes of locomotives, centered for the lathe, turned and ground. The tapered fits are left rough turned, as the piston head and crosshead fits vary in size and tapers. These rods are placed in the rack intended for new rods only. Piston rods that have been removed because of being under size are used on smaller locomotives. Where piston rods are too small for any class of locomotive, they are placed in the rod rack located at the turret lathe where they are turned into different sizes of driving brake hanger pins and stored in the stock room for enginehouse emergency use. In this manner the old rods are utilized to good advantage.

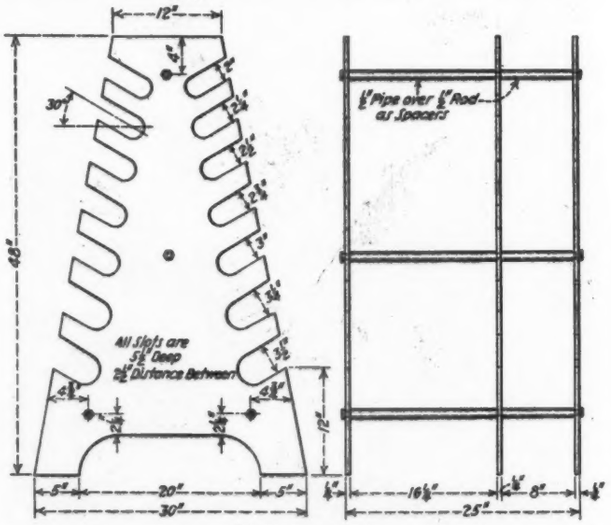
The piston rod rack is constructed of ¾-in. by 5-in. bar iron, bolted together with ¾-in. square head bolts. The arms that support the rods are machined to a 3⅜-in. radius.

A boring bar and gear arbor rack is essential in a large shop as it can be used to hold the different size



Piston rods can be held along the sides and bottoms of this rack

boring bars used on the horizontal boring mill and also for the storing of the different size milling machine arbors. It can also be used in the tool room for holding gear blank arbors and also at the turret lathe for holding the different sizes of round and square stock ready for use. In this manner the tools and stock are kept in a convenient place close to the machine to be served

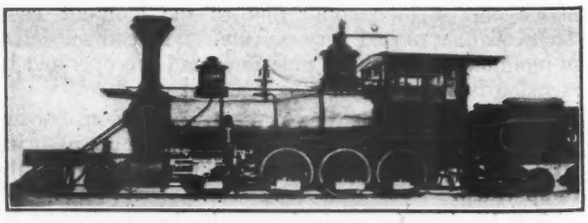


This rack is used for holding boring bars, bar stock for turret lathes and milling machine arbors

without the workman having to walk to the tool room.

These racks are made of ¼-in. or ⅜-in. steel boiler plate. The brackets are first drilled to the proper dimensions and then cut out with the acetylene torch. They are bolted together with ½-in. rods and spaced apart with ½-in pipe which makes a strong and rigid rack that requires very little space.

* * * *



An Erie Consolidation type locomotive of 1877—20-in. by 24-in. cylinder and 50-in. driving wheels

Practical kinks developed in the Japanese Railway shops

Many can be used to advantage in American practice— Prizes in money offered for labor and time saving ideas

THE Imperial Japanese Government Railways, consisting of approximately 8,000 miles of main line, 3 ft. 6 in. gage, operate in round figures 4,000 steam locomotives, 80 electric locomotives, 9,000 passenger cars, 1,000 cars used in electric trains for suburban service out of Tokio, and 60,000 freight cars. This equipment is repaired in 21 locomotive and car shops in which are employed about 12,000 men.

In order to increase shop output and reduce maintenance costs, the majority of the mechanics have been put on a piece-work basis. This system has made it possible to obtain an average of seven days in the shop for locomotive class repairs, one day for freight car repairs and eight days for passenger car repairs. Both the mechanics and shop supervisors make an effort to devise shop kinks to save time and labor. To further stimulate interest in the development of shop kinks, cash prizes are offered for practical ideas which will prove of benefit to the railway.

Most of the shop kinks are originated by the shop supervisory force. When a new idea for a shop kink is conceived, it is submitted to the higher mechanical department officers for approval. If these officers are convinced that the savings to be effected by the utilization of the device justifies the expense of making the tool, they authorize its construction.

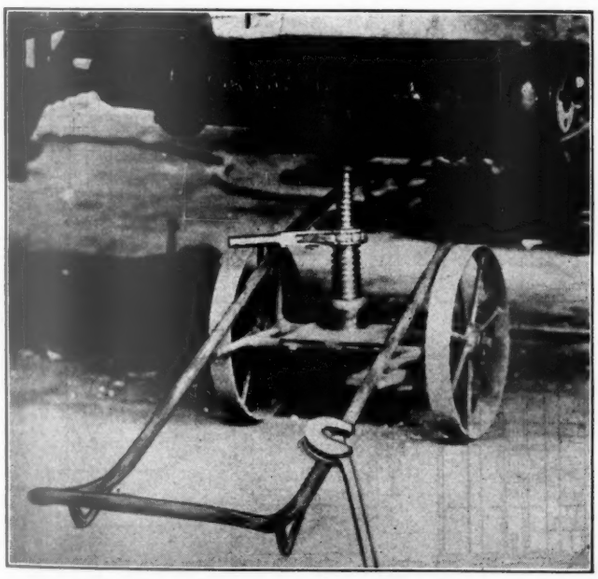


Fig. 1—Two wheel cart and jack holding an air cylinder in place for attachment to the car underframe

The following selection of special tools and devices thus developed is printed because of the interest they hold, as coming from an eastern country which has extensively adopted western methods and because many of them will, no doubt, be directly applicable, or at least adaptable, to American shop conditions.

Two carts for hauling heavy parts

When a car brake cylinder, auxiliary reservoir and triple valve is assembled in one unit, it is difficult to place and hold in position while being bolted to the car underframe. This difficulty has been overcome by using the two-wheel cart, shown in Figs. 1 and 2. The frame and jack is supported on two 16-in. diameter wheels built up by the welding process. A curved pan, 14 9/16 in. long by 7 3/16 in. wide, is attached to the end of the jack screw. The unit is placed on this pan and moved in position under the car. Here, a ratchet wrench is used to elevate the cylinder to the correct heights for bolting it to the car. Fig. 1 shows how firmly the cart rests on the floor while holding a cylinder in position.

Handling heavy locomotive springs is a difficult and awkward job. Figs. 3 and 4 show an all welded, two-wheel cart with which springs can be handled in an expeditious manner. With the spring sitting on the floor horizontally, one end is passed through the U-shaped hanger on the crossbar, located near the upper end of

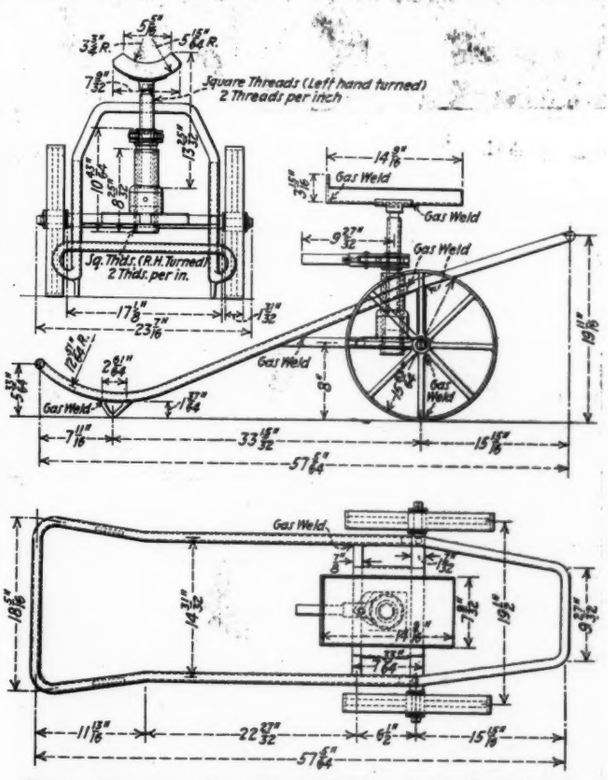


Fig. 2—Drawing of cart for handling air brake cylinders

the rectangular frame. The opposite end of the spring rests on the lower end of the frame. In this suspended position the spring can be readily moved about the shop. To unload the spring, the front end of the frame is permitted to touch the ground, which causes that end of the spring to free itself. The opposite end then may be easily slipped from the U-hook.

Tool holders and fixtures

It is sometimes necessary to cut spanner wrench slots in new union nuts or to recut worn slots so that

Fig. 3—A handy two-wheel cart for handling locomotive springs

the wrench will take a hold. The tool holder, shown in Fig. 5, is well suited for this work. The device consists of six cutting tools, located equidistant around the circumference of the tool holder. The tools are moved

Fig. 4—A spring in position ready for movement

in or out to suit the diameter of various sizes of union nuts by a cam, which is operated by the worm gear and handle shown. The nuts to be slotted are held on an arbor which is bolted to the slotter ram. Thus, the tools remain stationary while the work is forced through them by the slotter ram. With this tool it is possible to cut six slots at the same time and to slot four union nuts

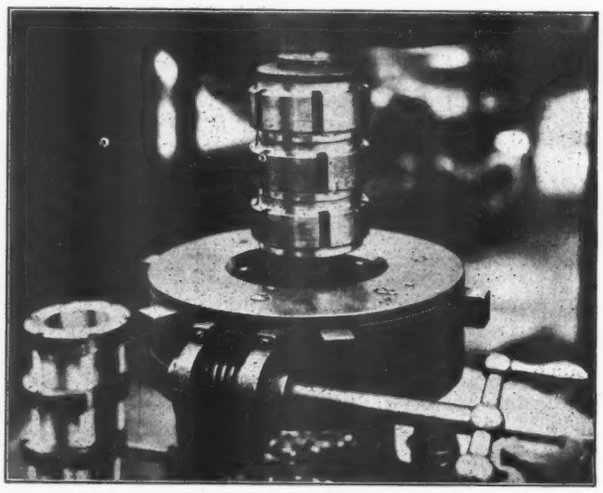


Fig. 5—A device for cutting slots in union nuts

in one operation. The tool eliminates any laying out and machines the pitch and depth of the slots to the exact dimensions.

Many fixtures have been developed for finishing the semi-circular surface on a connecting rod brass in order to eliminate the unsatisfactory result obtained with

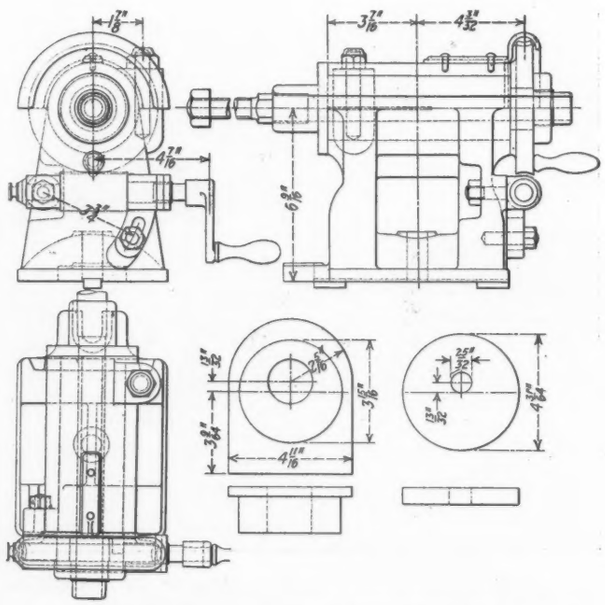


Fig. 6—A fixture for shaping connecting rod brasses

hand filing. The fixture used on a shaper, shown in Fig. 6, has merit in that its design effects extreme accuracy in the finished brass. The brass is placed on the spindle with the guide to hold it in position. It is held firmly in place by a nut and washer. The plane surface of the brass should be parallel with that of the guide. The brass can be set in position by turning the

spindle by the worm and worm wheel. The spindle is held in position by the 5/8-in. bolt.

The usual method of laying off an irregular piece of work on a surface plate is to use jacks, wedges, etc., to aline the part with respect to the surface plate. This requires much time and is sometimes rather difficult to do, owing to the irregular shape of the work. The use of the scribing device, shown in Fig. 7, eliminates much

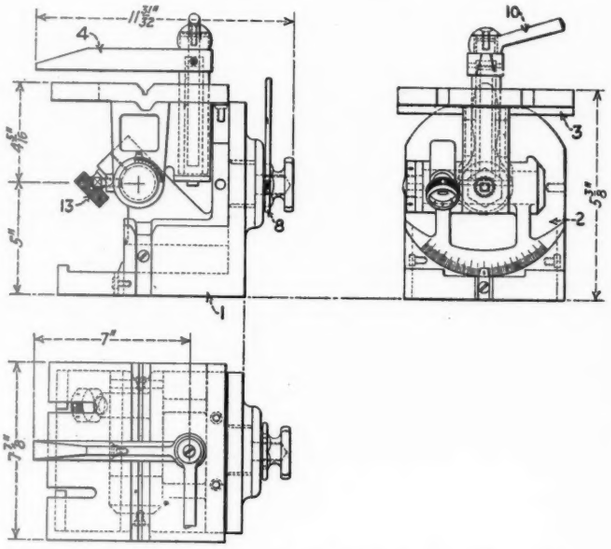


Fig. 7—Scribing device for laying out irregular work

of this trouble as a piece of work can be laid off at any angle of inclination. Referring to Fig. 7, the part to be laid out is held firmly in position by the clamp (4), which is tightened by handle (10). Table (3) and part (2) can be inclined to the left or right, the angle of inclination being indicated on the index dial. The angle shaped part (1) and part (2) can be clamped together by turning the handle (8). Table (3) can be placed in any position by turning the knurled handle (13). Therefore, the compound movement of parts

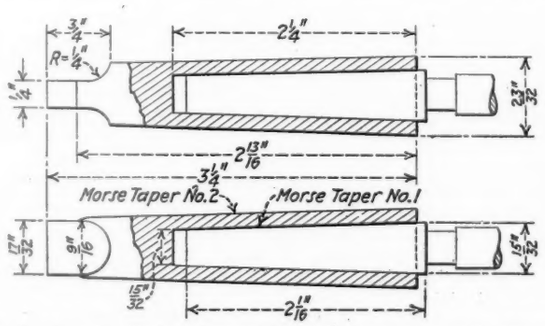


Fig. 8—A drill socket for utilizing twist drills with broken tongues

(1), (2) and (3) produce a universal motion which makes it possible to incline the clamped work in any position. Thus, an irregular part can be scribed or holes laid out quickly and accurately.

Using scrap drills—A drill motor holder

Most of the twist drills used in the Japanese shops are made of high speed steel. The average number of drills per month scrapped owing to wear or breakage, from April, 1926, to January, 1927, amounted to about 88 drills. These drills are utilized in the following way: All twist drills, 1/2 in. or above in diameter, have tapered shanks. About 10 per cent of all of the scrapped drills are chargeable to broken tongues. If

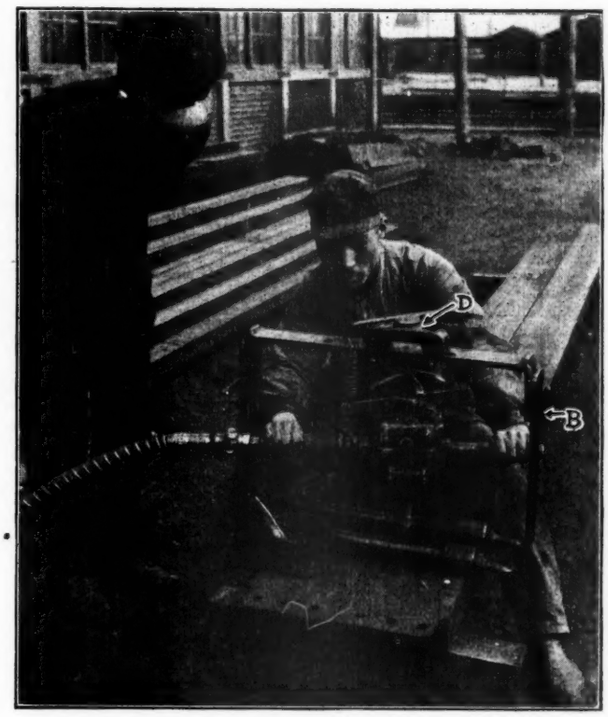


Fig. 9—A frame for holding an air motor while drilling car sills

the tongues of 1/2-in. to 7/8-in. drills are broken, they are used again by shrinking the shanks into the sockets shown in Fig. 8. Socket No. 2 is used for drills with Morse taper No. 1 and socket No. 3 for drills with Morse taper No. 2. It requires about 1 hr. 50 min. to

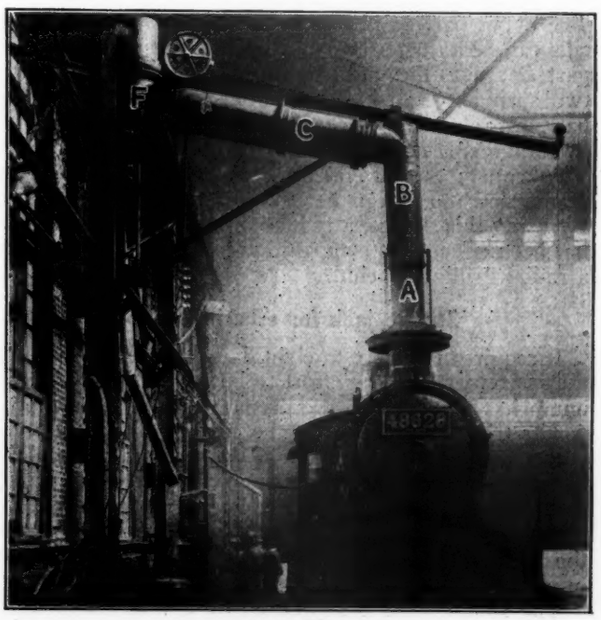


Fig. 10—The smoke jack in position

machine the socket and about three minutes to complete the shrinkage fit. Other scrap drills are used for making tool bits or small tools, such as the rollers of pipe cutters.

In order to reduce the time and expense involved in moving and setting up freight car side sills on a radical drilling machine, the device, shown in Fig. 9, has been worked out so that the sill can be drilled on the floor. The upper part of the frame, which passes around two sills can be adjusted to any height by the bolts *B*. The part *D* serves the purpose, through the medium of the two springs, of lifting the motor after the feed screw has been released. The motor is moved to the next hole by rolling part *D* along on the top member of the frame. Two rollers are provided at the bottom so that the frame and motor can be easily moved along the sills. By using this device, a reduction in time of 25 per cent has been effected as compared with the time required on a radial drilling machine.

Smoke jack for erecting shops

It requires from six to eight days to give a locomotive a class repair, and the effort to keep this time to a minimum has extended to the preparation of a locomotive for its trial run. In one of the Japanese locomotive repair shops, a smoke jack, shown in Figs. 10 and 11, has been provided, which has made it possible to reduce the preparation time about five hours, as the locomotive is fired up as soon as it has been wheeled. In the past, the locomotives have been fired up outside of the shop in order to keep the smoke out of the shop.

The smoke jack is supported by a wall crane which is attached to one of the building columns. The sloping smoke stack, to one end of which is attached the vertical adjustable smoke jack, swings at the point *F*. The smoke passes through the smoke jack and slopping stack to the smoke duct located just above the point *F* and then to the outside of the building. The lower part of the smoke jack or section *A*, can be adjusted to any height of locomotive. When the locomotive is moved on the track, as is the case when setting valves, the stack swings at *F*. Section *B* of the stack slides in section *C*, which makes it possible to adjust it to any length. This adjustment is made by manipulating the loop chain which passes over a pulley and is fastened to the upper end of the smoke jack.

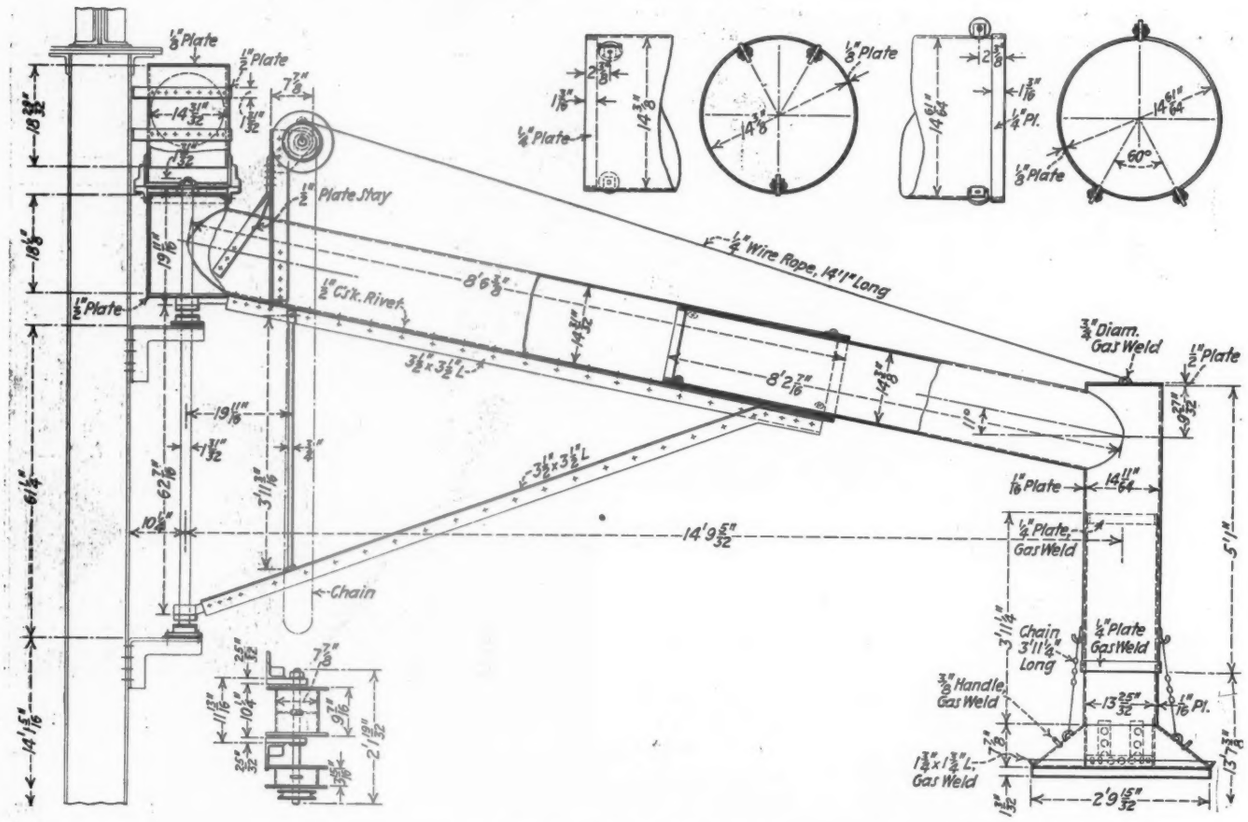


Fig. 11—The drawing of the smoke jack for use in a locomotive repair shop

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SUNDSTRAND MACHINE TOOLS.—The Sundstrand Machine Tool Company, Rockford, Ill., in the first half of a recent bulletin analyzes the principles of design used in the construction of the Nos. 1, 2, 3, 4, 5 and 6 stub lathe and Rigidmil. The second half of the bulletin describes and illustrates the application of these principles.

THE SUPERIORITY OF ACETYLENE AS A FUEL GAS FOR CUTTING.—This 24-page booklet, published by the Acetylene Journal Publishing Company, Chicago, contains two studies of acetylene as a fuel gas for cutting which were prepared by J. K. Mabbs of the Union Carbide Sales Company, New York, and J. L. Anderson of the National Carbide Company, New York, respectively, for presentation at the 1927 annual meeting of the International Acetylene Association. The comparative merits of acetylene and city gas and the shop viewpoint are the subjects discussed in these studies, the latter paper by Mr. Anderson including reports of experiences of a number of users of both gases. Copies of the booklet can be obtained by addressing the office of the secretary, International Acetylene Association, 30 East Forty-second Street, New York.

Keeping the Atlantic type locomotive in quarter

By J. L. Kemp
Enginehouse foreman, Pennsylvania, Warren, Pa.

THE question, "What will cause an Atlantic type locomotive to slip the driving wheels when it is being operated with a closed throttle at speeds between 20 and 50 m. p. h., with the rail in a dry condition?" has caused much controversy.

Not so many years ago, the cause of this condition was pretty much in the dark. An engineman, who reported an Atlantic type locomotive slipping when shut off, was due for a "third story" inspection, at least this was the opinion of the personnel of most enginehouses.

However, it was usually an easy matter for the engineman to prove his statement that the engine did slip.

After considerable study and experiment, it was developed that changing the center to center distance, of the crank pins, without changing the center to center distance of the axle, would cause an Atlantic type to slip with the throttle closed. This irregularity was, without exception, found to be caused by the front driving wheels being out of quarter in either direction of the relative crank pin location. When the throttle is shut off, the power to slip the driving wheels obviously must come from the rods. This rod power is developed at four points and four times for each revolution of the wheels.

Let us assume that the locomotive is of a left-hand lead type and that the crank pins on the right side are on the back center. The center to center distance of the axles and crank pins will be the same on the right side. On the left side, the crank pins are on the top quarter and if the pins are out of quarter, a different condition will be found on this side. The center to center distance of the axles will be the same on this side as on the right side, but the center to center distance of the pins on the left side will be long or short.

It will be readily seen that, with the crank pins on the same axle set at 90 deg., if this angle has been reduced, the center to center distance of the crank pins on the left side will be less and if the angle has been increased, this distance will be greater. If the crank pin angle has become less than 90 deg., the side rod on the left side will be placed in compression and if the pins are out of quarters, the rod will bend slightly.

When the wheels are moved so that the crank pins on the right side are off center, the side rod on the left side releases its stored energy by assuming its normal position, giving the front crank pin a short, powerful push in the direction of wheel rotation. As the crank pins on the left side move down to the front center position, the right side rod is placed in tension and when the crank pins on the left side move off of the front center position, the right side rod gives the main pin a short, powerful pull in the direction of the wheel rotation. If the relative crank pin position angle is more than 90 deg., the conditions are the same except that they take place at opposite intervals.

The Atlantic type locomotive is the only type that will slip with the throttle closed when out of quarter. If this type of locomotive is allowed to remain in service with the wheels out of quarter, the result is another engine for the back shop.

Putting the front wheels out of quarter is an easy matter and is usually accomplished by having one front sand pipe stopped up or out of line with the rail. If the engineman opens the throttle while the engine is still slipping and sand is applied to the rail through one front sand pipe, the terrific momentum of the four wheels and rods is suddenly checked by the one front wheel to which sand has been applied, with the result that the front axle is twisted or the center is sprung on the key, throwing the front wheels out of quarter. Sand applied under the right front wheel of a left-hand lead type locomotive, will result in the relative crank pin position angle becoming more than 90 deg.

Keeping the Atlantic type in quarter is not difficult. The enginehouse despatching such a locomotive should know that all the sand pipes are open and working properly. The engineman in charge of this type of locomotive should not sand the rail while the engine is slipping, even if he knows that the sanders are working properly, as oft-times the wind will blow the sand off the rail on one side.

An easy method may be employed at any enginehouse for checking wheels reported out of quarter. Remove the rods on both sides, place the crank pin on one side on the top quarter. To get this pin exactly on top, find the dead center of the axle and from this point scribe a circle the exact size of the crank pin on the end of the axle. Lay a piece of twine over the crank pin, weighted at both ends. The weights must not touch the ground. Move the wheels until the twine lines up with the circle scribed on the end of the axle. This will place the crank pin directly above the center of the axle on this side of the engine. On the other side of the engine, find the dead center of the axle and from this point scribe a circle on the end of the axle the exact size of the crank pin on that side.

With a spirit level and a straight edge laid over the crank pin and lined up with the circle scribed on the end of the axle the amount the wheels are out of quarter can be readily determined. This method has been checked against quartering machines and if the work is done carefully the findings can be relied upon.

The amount that the wheels get out of quarter is entirely dependent on the severity of slipping at the time the momentum is checked. Wheels found to be out over 5/8-in., usually will not run, due to rod failure, hot pins, or pin failure. The front wheels of any type of locomotive may get out of quarter if caught on sand while the engine is slipping, but this condition will not be detected until the engine goes through the back shop for class repairs. However, while the locomotives are in service with the wheels out of quarter, a certain amount of damage is taking place to the parts involved.

Electric locomotives

Some 4-4-0, 0-4-4 and 2-4-4-2 electric locomotives, have incorporated in them side rod connected running gear. While these locomotives do not slip violently, greater power is required to check the driving wheels of this type of locomotive than those of the steam type. This condition is caused by centrifugal forces set up in the jack shaft and the motor shaft.

An electric locomotive caught on the sand while slipping with the power on, will not only throw the front driving wheels out of quarter, but is likely to throw the jack shaft pins out of quarter and damage the motor shaft or pins, inasmuch as these parts are built solid and set on quarters. These parts on some locomotives are quartered so as to make the gear a left hand lead type, regardless of the direction of the wheel rotation or locomotive operation. Considering the work involved and the expense to repair an electric locomotive with wheels that have been thrown out of quarter, much money can be saved by keeping a close check on the conditions causing this trouble.

The Reader's Page

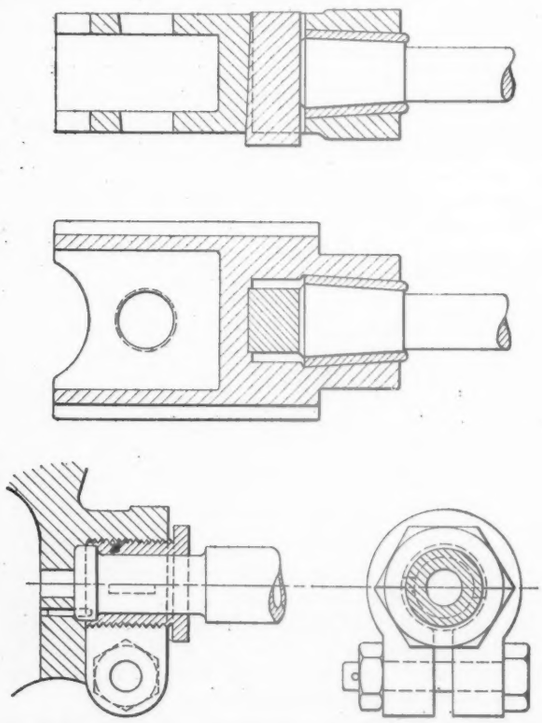
Have You a Question? Ask it
Have You an Opinion? Express it

Securing crossheads to piston rods

GALVESTON, TEXAS

TO THE EDITOR:

"General Foreman's" article on page 15 of the January, 1928, *Railway Mechanical Engineer,* brings up a question that was troublesome long before 5-in. piston rods became common. A considerable discussion of the subject will be found in the Proceedings of the American Railway Master Mechanics' Association for 1911. A type of connection, somewhat resembling Method No. 5 on page 16, was formerly used extensively by the Southern, the Chesapeake & Ohio, Norfolk & Western, Chicago, Burlington & Quincy and other railroads. The superiority of this design; viz., using a nut instead of a key at the crosshead end of the



The two views at the top show the piston rod tapered at the end—The bottom sketch shows a split nut assembly

piston rod, was claimed by several speakers at the 1911 convention.

But crossheads and piston rods of this kind are very rare on new power today in spite of the trouble experienced with the key type of attachment. In general it may be said that any satisfactory substitute for the key connection will entail an increase in the weight of the crosshead. Reciprocating parts are heavy enough already and this fact, together with the simplicity of the key, may account for its general use today.

It would be interesting to know how many of the methods illustrated by "General Foreman" have been actually tried on locomotives. The two designs depicted on the drawing included in his article have seen actual service, the first on the Western Railway of France and the second on George S. Strong's 4-4-2 balanced compound locomotive which was built about 1895. As far as I know, neither are in use now. They are interesting as indicating possible solutions of the problem, although neither could be recommended on the ground of simplicity, or ease in assembling and dismantling.

In the two top views of the sketch it will be noted that the end of the piston rod is tapered in the opposite direction to that necessarily used with keys. In assembling, the piston rod is brought as far back into the crosshead opening as possible to permit the insertion of the several segments of a sectional bushing. The rod is then wedged into position, as shown.

In the bottom assembly, a split nut surrounds the end of the piston rod and is screwed into the cross head opening, the end of which is split and provided with a nut and bolt for clamping the rod. A dowel pin prevents the rod from turning in the crosshead.

WM. T. HOECKER

Handling hard grease in the shop

DETROIT, MICH.

TO THE EDITOR:

Will you ask your readers for information as to the best way to meet the newer demands for pressing hard grease into suitable cakes or bricks for the driving box cellars of various sizes and shapes? Also some up-to-date information on the whole hard grease question would be of considerable interest.

It is well known that recently a much harder form of non-moisture grease is being provided than was formerly the case. It has been found that, even with 100 lb. air pressure, the method which was quite satisfactory with the old grease is now altogether too slow. The only machine on the market offered for this specific purpose will not handle the new hard grease at a sufficiently rapid speed. It is found necessary to use a special wide cutting chisel and a pneumatic hammer in removing the grease from the barrels. Running a steam pipe coil into the cylinder while pressing the grease is not considered satisfactory.

Have any of your readers made a good machine for this purpose and if so, will they not tell us about it? Also let us know how long it takes to form, say 24 bricks for 10 in. by 12 in. journals. How do they remove the grease from the barrels in which it is received from the manufacturer? Then, too, what disposition is made of the grease removed from engines

in the shop for general repairs? How is it taken care of? Where does it go? Who passes on its quality? What process does it go through? Is it kept separate from new grease or is it mixed with it?

A SHOP SUPERINTENDENT

Revision of braking power for freight cars

NEW HAVEN, CONN.

TO THE EDITOR:

Referring to the article in the November, 1927, issue of the *Railway Mechanical Engineer,* entitled "Proposed revision of braking power for freight cars" by L. K. Vial. It appears to me that the railroads throughout the country do not consider the grave importance of maintaining the correct braking power for freight cars. The greatest trouble is found on rip tracks, and outlying repair points, where repairs are made to all kinds and classes of cars, regardless of ownership.

It is reasonable to assume that a repairing line does not carry in stock, brake levers or rods for repairs to all foreign cars. A car comes into a rip track with a brake beam and its associated rigging missing. In most cases the inspector will get the dimensions for the levers from the other end of the car, if it is possible. In many cases the rods and levers are applied to cars without ascertaining whether or not they are standard to the car. When this car is repaired, the repairman, in most all instances, does not know whether or not he has jumped the braking power to 90 per cent or reduced it to 40 per cent. Right there is the greatest obstacle to overcome in the proper maintenance of braking power.

What good is this revision of braking power if, after it has been revised, it is not maintained? How many railroads in this country make periodical checks on their own equipment to ascertain whether or not the correct braking power is being maintained.

This could easily be done if blueprints were furnished to all symbol repair points. System cars could be checked periodically and this would eliminate a great deal of irregular braking power. You will find that some cars are braking as low as 10 per cent and some as high as 210 per cent. Very few will be found that are braking the required 60 per cent.

If more attention were paid to the piston travel on cars, it would help to reduce the number of slidflat wheels. Too much cannot be said about the retaining valve and great care should be taken in making retaining valve tests. Many times when a certain series of cars is sent through the shop for general repairs, each car is reinforced to a great extent, thus increasing the light weight of the car. No attention is paid to the type of brake equipment on the car in regard to 8-in. or 10-in. cylintlers. Quite a number of cars in service today have 8-in. equipment when they should have 10-in. equipment and vice versa.

It is highly improbable that the railroads can prevent all slidflat wheels, as there are innumerable conditions which cause this defect. But, they can maintain the correct braking power on cars and thus eliminate the greatest factor in the problem of overheating wheels.

JAMES MCDONNELL.

Draft gear inspection expense justified

MINNEAPOLIS, MINN.

TO THE EDITOR:

Answering the query as to whether or not I consider it worth while to take down and inspect draft gears periodically: I must certainly say that I do and I do not think money can be spent in the car department in a better way or in any way that will bring any bigger returns.

We have been following the practice for some time and we have already noticed that there is a great improvement in the condition of our cars and there has been a big reduction in the number of cars set out for bent, cracked and broken center sills, crushed body transoms, etc.

In investigating the failure of center sills draft members, etc., on a series of steel frame cars, it was noticed that in almost every case where center sills were found bent, cracked or broken the friction draft gear would be found defective on the same car and the defect in the friction gear was usually somewhat old, older in fact than the defect in the center sills. The defect in the friction gear would not be noticed in the ordinary transportation yard inspection and would only be discovered by the removal of the gear.

The conclusion arrived at was that the defective gear was responsible for the failure of the center sills. We have found, by periodically removing the gear for inspection and replacing worn or defective parts, that it has eliminated a lot of center sill and draft gear failures.

Our practice is to remove, inspect and repair friction draft gears on all system cars once in each three years as cars pass over the shop or repair tracks. The date and station symbol are stencilled on the draft members or center sills at each end of each car and a record is kept of the work. Each repair point reports to the main office each month the number of cars on which friction draft gears have been inspected and repaired.

A car that has not had the draft gear tested and car stencilled within three years is considered out of date. Any such system car would have the friction draft gear removed and inspected when found on repair or shop tracks.

The plan is entirely practical and is automatically taken care of by repair forces in just the same manner that air brakes are cleaned and journal boxes repacked. In removing the gear periodically an opportunity is afforded to inspect the draft gear attachments thoroughly and quite often defects are found and repaired that would otherwise pass unnoticed until final failure, which might result in break-in-twos.

I feel sure that within a few years the periodical inspection of friction draft gears will be a requirement of the interchange rules and the quicker it is put into force the better.

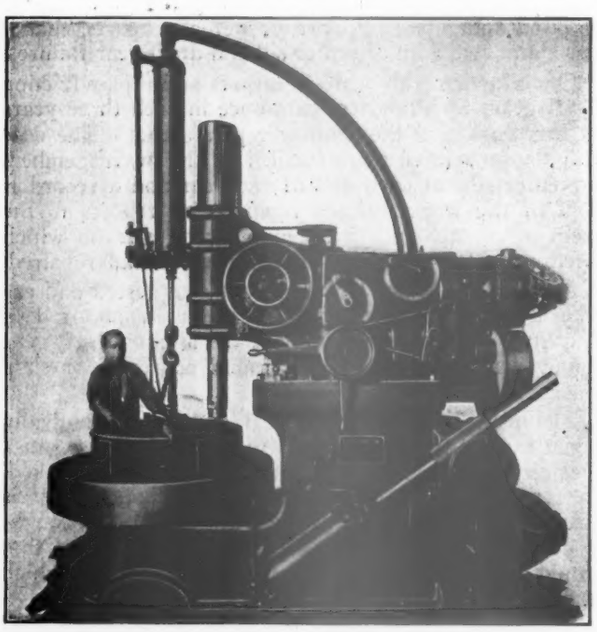
In starting such a campaign, the railroad will find that maintenance costs of friction draft gear will increase surprisingly until all of the gears have been gone over once, but the additional expense will be offset many times by the saving made in other car repair costs, less damage claims and delays caused by so-called rough handling, break-in-twos, etc.

E. J. ROBERTSON.

Superintendent car department, M., St. P. & S. S. M.

Car wheel boring and hub facing machine

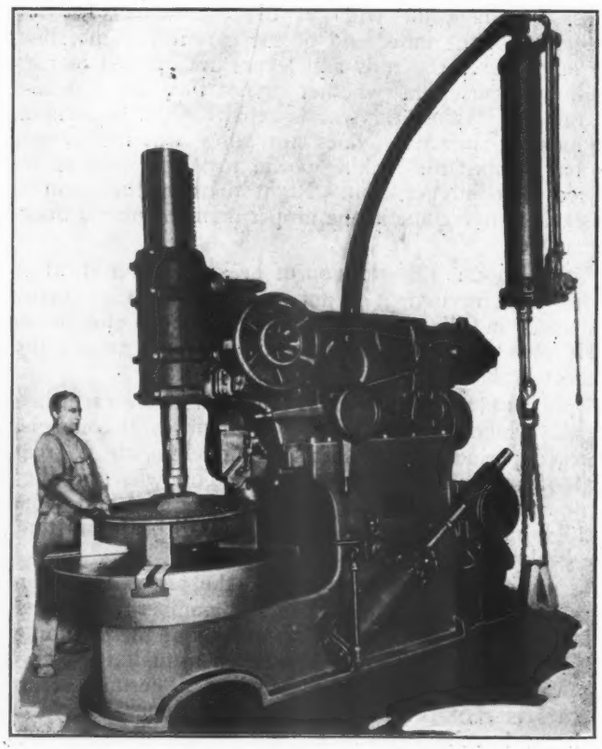
THE outstanding feature of the car wheel boring and hub facing machine recently placed on the market by the Southwark Foundry & Machine Company, Philadelphia, Pa., is the power backward and forward movement to the upper frame. This feature permits the crane to swing to a point directly over the center of the table and makes it an easy and rapid operation to mount rough wheels and remove finished work from the table. As can be seen from



The tool bar and hub facing slide drawn back, providing ample head room over the table chuck

a comparison of the two illustrations, the crane swings through a complete circle and has a high suspension and will thus cover a relatively large area of floor space. Any approved air, or electric hoist, can be used.

When the boring tool is drawn back from the center of the table, the tool bar needs to be traversed upwards only about two-thirds the amount ordinarily required for obtaining sufficient head room to mount or remove work. As the whole hub facing member is carried bodily backward with the upper frame the guide for the tool slide is brought well forward for the support of the facing tool against the heavy lateral pressure while facing hubs.



The tool bar in the central working position

The table is provided with five automatically closing and opening chuck jaws, operated by the driving power of the machine. The table spindle is tapered and of large diameter. A hole passes through the table for conveying the chips to the floor, from whence they are removed through an opening in the base of the frame. The table driving gears are of steel except one high speed gear of non-metallic material. The driving mo-

tor is 15 hp., which gives a speed range of three to one and table speeds of 10 to 30 r.p.m.

The boring spindle is 10 in. in diameter, with an enclosed counterbalance. There are six automatic feeds, three for roughing and three for finishing. In addition to the automatic feeds it has a rapid power movement in both directions. Likewise, the hub facing slide has three roughing and three finishing feeds and a rapid power movement. At the outer end of the hub facing slide is a tool slide with a vertical hand movement for setting the depth of cuts and for fashioning various hub shapes.

The feed mechanism is fully enclosed steel gearing, driven by a small constant-speed motor, connected to the panel of the main motor in such a way as to come to rest automatically the moment the driving power is switched off.

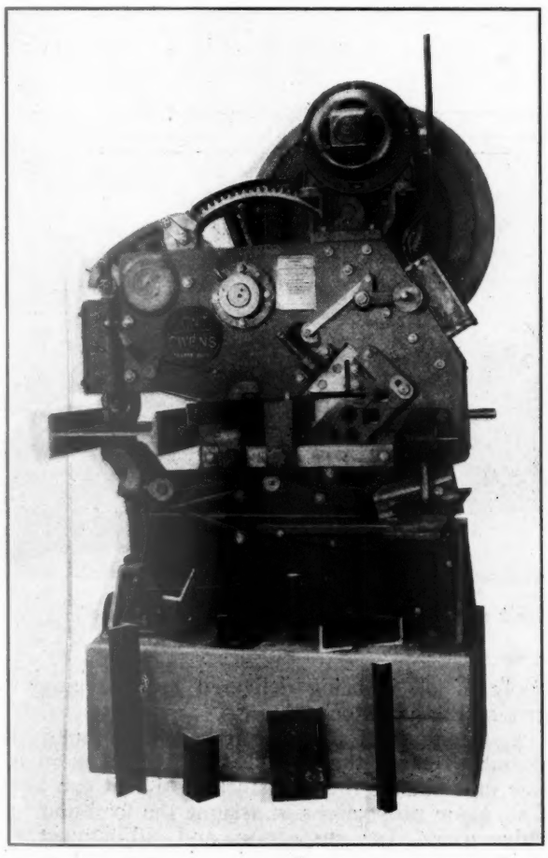
The draw-back movement of the upper frame is by a mechanism that positively holds the upper frame structure hard against stops in the lower portion, automatically locking the two frames together when the boring bar is in working position.

The power drawback movement on the machine is effected by an air cylinder, but an electric motor may be employed for this purpose when desired. As both the crane and the draw-back mechanism may be operated by air or electricity, any combination of these two units that is desired may be made.

The patents on the new features of this machine are pending.

Welded frame all-purpose iron and steel worker

THE all-purpose iron and steel worker, shown in the illustration, has been designed by the Kent-Owens Machine Company, 958 Well street, Toledo, Ohio, particularly to meet the needs of shops having a variety of work. The various tools provided



The Kent-Owens all-purpose iron worker showing a few samples of the work it will handle

for punching, cutting and mitering of sections, shearing of round and square bar stock and shearing flats and plates. A simple attachment also provides for coping and notching.

The mechanism is so arranged that the punch may be operated independently of any of the other tools; that is, one operator may be punching holes while a second is either cutting sections, bar stock or shearing plates. This compact combination of several tools in a single unit makes for a lower initial investment and generally reduced handling costs as compared with single purpose machines.

An interesting feature is the welded frame construction. The side members of the frame are rolled from special open hearth steel. These are electrically welded to intermediate forgings placed and shaped so as to provide the maximum rigidity. This welded steel frame not only gives the greatly superior strength of steel, but also is exceptionally rigid and is entirely free from the slipping or weaving of the side members as sometimes occurs when a bolted construction is used.

The punch is full floating with an adjustable stroke. It may be brought down to the surface of the work by a hand lever or else the stroke may be set so that it will always come to rest immediately above the work. This feature makes for the utmost convenience either when punching material of varying thickness or when punching a large number of holes in material of uniform thickness. The punch and die block are so constructed that unusually large clearances are provided for punching holes in the web ond flanges of I-beams, H-sections, channels and other sections without having to change tools.

An adjustable gage is conveniently located for cutting off sections either square or at any desired angle. The bar cutter has an adjustable hold down plate, all of the openings in which are clearly visible.

Interchangeable upper and lower steel knives, each with four cutting edges, are used in the shear. The welded construction permits unusually large clearance in the shear ways. These ways are free from any obstructions.

The bearings are all phosphor bronze lined. Lasting alinement is insured by the rigidity of the welded frame construction. Lubrication is by the high pressure Alemite grease system. All slides are counterbalanced to insure smooth adn easy operation.

The punch handles work up to a 1-in. hole in ½-in. plate. Angles up to 4 in. by 4 in. by ⅜ in. may be cut off square and up to 3 in. by 3 in. by ¼ in. mitered at a 45-deg. angle. Rounds up to 1⅝ in. and squares up to 1½ in. may be cut off in the bar cutter. The shear

takes flats and plates up to ½ in. in thickness. Machines of greater capacity are also available.

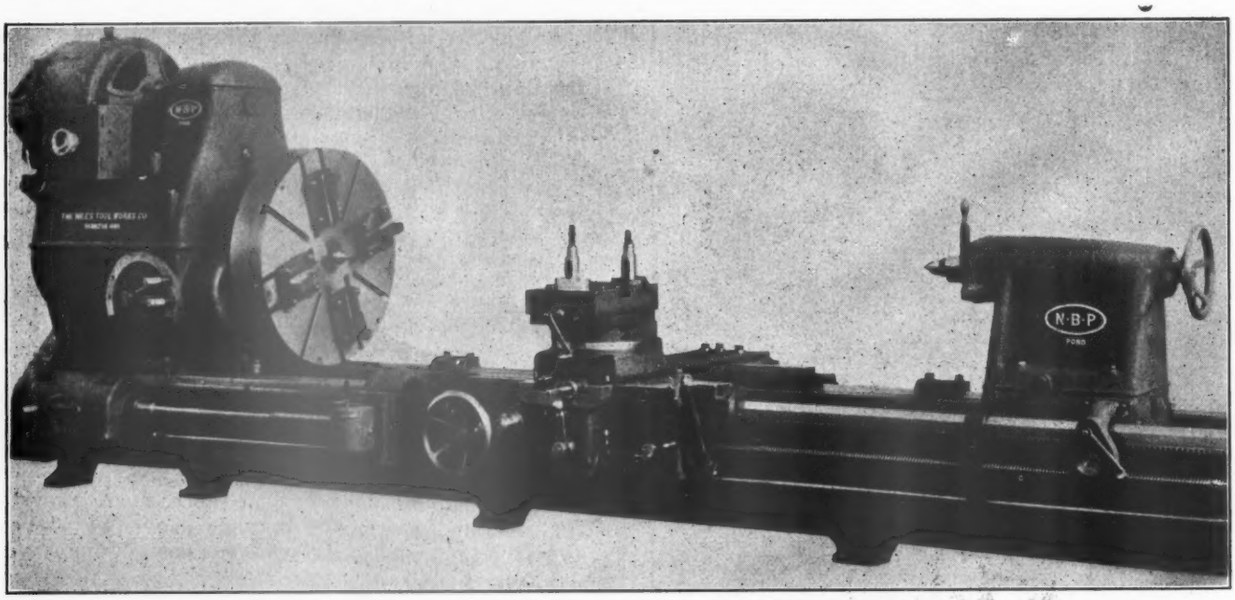
The machine may be arranged for motor drive, as illustrated, or for belt drive. Steel cut gears are used in the driving mechanism. Operations of the various tools are effected by a simple, positively acting clutch.

A 3-hp. motor is recommended. The weight is about 3,300 lb. The machine may be mounted either upon a concrete foundation, as shown, or on a structural steel box section.

Niles redesigned 42-in. engine lathe

REFINEMENTS in design have been made to the heavy engine lathes built by the Niles Tool Works Company, Hamilton, Ohio. This machine is rated at 42 in. capacity, having an actual swing of 43 in., with a bed length of 32 ft., but is typical in most respects of all sizes from 36 in. to 60 in. swing. The drive is by a 20-hp. variable speed motor, but may be increased to 25 hp. or more, according to the service required.

Improvements have been made, particularly in the headstock and carriage. The main spindle bearing dimensions have been increased about 40 per cent and other parts correspondingly. All gears in the head are now of steel, including a forged steel faceplate gear ring which has a diameter equal to the outside diameter of the faceplate and is shouldered and bolted to the faceplate. The faceplate is pressed on the spindle by an hydraulic press and accurately fits up against the large flange on the spindle to which it is also bolted, giving additional strength and rigidity.



Improvements have been made in the headstock and carriage of the Niles 42-in. engine lathe

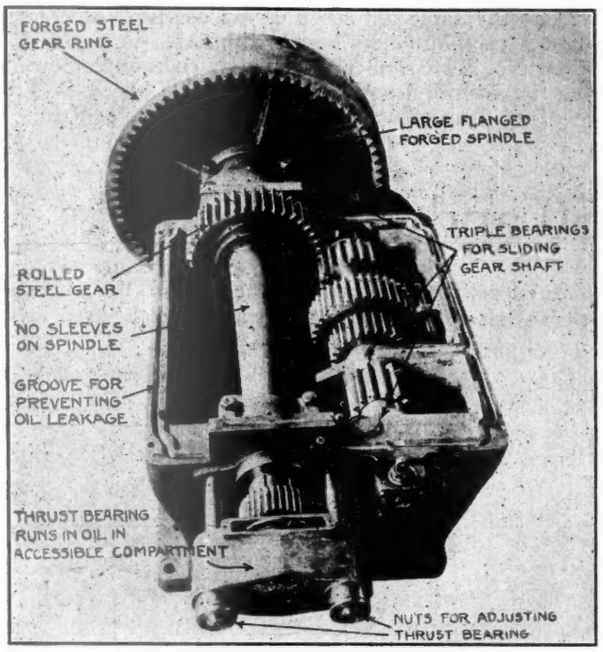
There are four mechanical changes of speed obtainable in the lower half of the headstock for either a.c. or d.c. drive, which in conjunction with the variation in motor speeds for d.c. drive, gives faceplate speeds ranging from 1.9 to 231 r.p.m. For a.c. drive the top half of the box has six additional mechanical changes, making 24 changes in all, ranging from 1.5 to 169.5 r.p.m. The pinion for the faceplate drive is located directly under the tool line so that the cut is pulled through the tool rather than pushed through, ensuring a much smoother drive. Direct drive to the spindle is made through a large gear pressed and keyed on to the spindle next to the front spindle bearing. This is the only drive gear on the spindle. The use of sleeves on the spindle has been eliminated. All gears and bearings in the head are supplied with forced lubrication by an oil pump which is driven from driving gears. The pump is direct connected so that when the machine is started up, oil is forced to the gears and bearings. The pump is bolted to a combination cover and bracket so it may be removed for examination merely by taking out the four holding bolts. The head is entirely oil tight and dust proof and particular attention has been given to the question of oil leakage by placing drains and covers at points where this is most likely to occur. An oil indicator is located in a prominent position so that the operator may be sure that an ample supply of oil is being delivered by the pump to all parts of the headstock.

On machines of this size it has been found advantageous to carry the spindle thrust bearing in a separate unit outside the headstock so that it can be made of adequate proportions to assume the load and to give ready access for inspection and adjustment. The thrust is taken on a hardened and ground block with a special bronze washer on the spindle. The thrust plates dip in an oil compartment, oil being carried by slingers over the entire surface of the bearing. Adjustment is made by a spanner wrench on two nuts on the ends of the bolts carrying the thrust bracket.

With direct current drive the faceplate is quickly stopped by a dynamic braking, but in a.c. drive a mechanical brake is incorporated in a gear box which is operated from the motor control lever on the carriage. Moving

the lever to the "off" position automatically applies the brake. A jog button in the headstock serves the dual purpose of slightly turning over the gears while shifting and for inching the faceplate through small increments for setting up or inspecting work.

The motor pinion shaft is supported between two bearings independent of the armature shaft bearings so that motor bearings carry only the loads induced by the motor itself and is not subject to any loads from the gears.


FORGED STEEL GEAR RING
LARGE FLANGED FORGED SPINDLE
TRIPLE BEARINGS FOR SLIDING GEAR SHAFT
ROLLED STEEL GEAR
NO SLEEVES ON SPINDLE
GROOVE FOR PREVENTING OIL LEAKAGE
THRUST BEARING RUNS IN OIL IN ACCESSIBLE COMPARTMENT
NUTS FOR ADJUSTING THRUST BEARING

The lower half of the headstock

The carriage apron is of a new design. The carriage is supported on the bed on vee tracks, but the bridge also has a flat bearing on the inner edge of the front shear, giving a solid bearing directly under the tool. The carriage is gibbed underneath the track at front and back and can be securely clamped in position when cross feeding. A graduated swiveling tool slide with four clamping bolts and tool straps is regularly furnished instead of the two poppet tool holders as shown. Provision is made for power angular feed which may be supplied as an additional feature on the 36-in. and 42-in. lathes, but is regular equipment on the lathes from 48-in. up. Power rapid traverse to the carriage is also optional on the 36-in. and 42-in. sizes and standard construction on the larger sizes. A separate reversing motor, used for this purpose, is mounted on a bracket on the carriage and connected by gearing with the feed rack. The rack pinion may be withdrawn when cutting threads, insuring a smooth movement of the carriage and complete disengagement of gears in the feed and traverse train.

The apron is a one-piece casting, assembled as a self-contained unit. An oil reservoir is provided in the top, oil being led to all gears and bearings through brass oil pipes. This reservoir is filled through holes in top of the carriage. Feeds are engaged and reversed by sliding gears and positive tooth clutches, friction clutches for this purpose having been eliminated. The lead screw is splined for the full length and drives a double fine tooth clutch which engages either one of two bevel gears. The clutch is moved by a lever at the front of the apron. This provides a means of changing the direction of the feed or of stopping the feed by throwing it into neutral. A lever for securing either cross or longitudinal feed is located at the side of the apron. This lever controls a sliding gear which in one position is in engagement with the cross feed gear and when thrown in the other direction connects with the gear train to the rack for longitudinal feed. The lever for engaging the lead-screw nut is interlocked with the feed so that it is impossible to throw both in at the same time. All gears in the apron are of steel and are doubly supported on large shafts. The rack pinion also has a bearing at its outer end. The feed gear box provides four changes of feed and threads by sliding gears and clutches instead of the usual tumbler gearing. Change gears for additional feeds and threads are furnished.

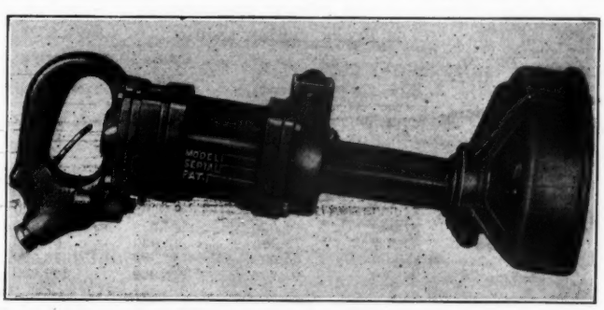
The tailstock is held to the bed by four large bolts and to prevent possible slipping under heavy loads, it has a pawl which engages with the brace rack in the bed. The tailstock spindle is clamped by a double plug locking mechanism which does not disturb the alinement of the spindle.

Thor rotary grinders and sanders

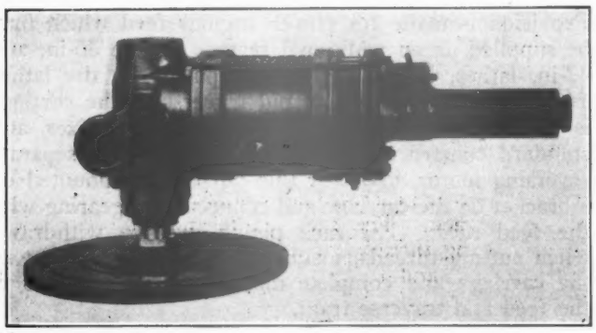
THE Independent Pneumatic Tool Company, 600 West Jackson Boulevard, Chicago, has placed on the market a line of rotary air grinders and sanders which are designed on new principles. The features of these tools are the perfectly balanced, vibrationless motor, the governor, the lubricator and the muffler. The motor, carrying four balanced Bakelite blades which are unaffected by oil, water, or heat, is very light. It is mounted on a rigid shaft, suspended in oversize ball bearings. The spindle is also suspended and held in alinement by extra large ball bearings at each end, making a perfectly balanced, frictionless motor.

The governor, which is adjustable, is fully enclosed. It keeps the free speed and air consumption low, until the wheel is applied to the work and then it automatically throttles to the speed and air required for the job.

The automatic oiler carries sufficient light oil perfectly to lubricate all moving parts for eight hours, thus



The Thor No. 272 grinder which carries an 8-in. emery wheel with a 1½-in. face



Thor No. 271R rotary sander with a right angle housing

preventing the wear usually experienced in dry rotary machines. The baffle plate muffler, incorporated in the box-like lug on the spindle support, makes a quiet, comfortable motor to handle.

The Thor No. 271 grinder weighs only 15½ lb., is 21¼ in. long overall and has a straight handle throttle. The speed is 4,000 r. p. m. The air consumption at no load is 20 cu. ft. at 90 lb. It is furnished with a 6-in. emery wheel having a 1½-in. face. The Thor No. 272 grinder weighs 17¼ lb., is 19¾-in. long overall and has a grip handle throttle. The speed is 3,200 r. p. m. It has the same air consumption as the No. 271. It carries an 8-in. emery wheel with a 1½-in. face. The Thor No. 271R sander which has a right angle housing, has an overall length of 14 in. The speed is 4,000 r. p. m. It carries any size flexible disc up to 9. in.

A friction spring for 50 and 70-ton trucks

THE Frost Railway Supply Company, Penobscot building, Detroit, Mich., has recently placed on the market a friction type coil spring for use in spring clusters on freight car trucks. This spring conforms to A. R. A. standards as to diameter and height

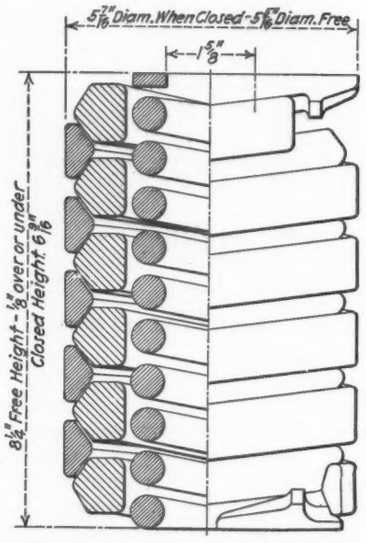
Frost friction truck springs for a 70-ton car

and is interchangeable with coil springs used in A. R. A. Class D and H clusters for 50 and 70-ton trucks. The new spring is of the double coil type, the outer coil being an adaptation of the Harvey friction spring designed, in this case, to act as a suspension spring instead of a buffer spring. The inner coil is of the conventional helical type.

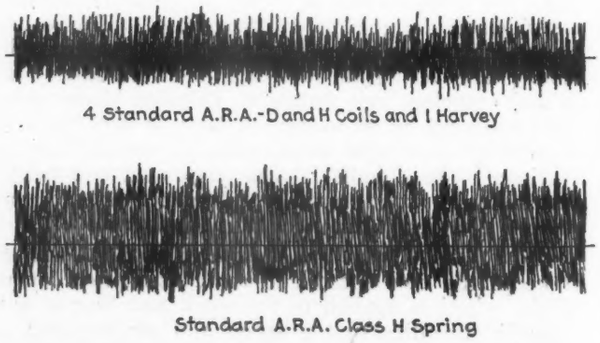
Comparison of load and release pressures of a Class H and a Frost friction spring

Height of spring, In.	A. R. A. Class H cluster		Frost friction spring (Four standard coils, one Harvey spring)	
	Compression, lb.	Release, lb.	Compression, lb.	Release, lb.
8—1/4	0	0	0	0
7—1/8	58,000	54,000	61,000	48,000
7	65,000	61,000	69,000	54,000
6—7/8	71,000	67,000	76,000	60,000
6—13/16	74,000	71,000	80,000	63,000
6—3/4	77,000	73,000	85,000	66,000
6—11/16	80,000	76,000	90,000	69,000
6—5/8	85,000	81,000	103,000	78,000
6—9/16	98,000	91,000	146,000	109,000

In developing this spring the aim of the manufacturers has been to provide a spring which, used in the cluster in combination with standard A. R. A. coil springs, will act as a snubber or dampener of spring reaction to prevent the excessive rolling of freight cars with the resultant damage to car trucks and, in many



Sectional view of frost frictional spring showing inner and outer coils



Composite full load spring record obtained on a 70-ton car traveling 250 miles

cases, derailment of the car. The Frost friction spring is designed to absorb a part of the energy set up by a rocking car without the undesirable kick-back inherent in helical springs. The action of the new spring is best described by a comparison of tests on two five-spring clusters such as used for 70-ton trucks, one consisting of the A. R. A. Class H spring and the other four A. R. A. Class H coils in combination with one Harvey friction coil. The table will show the compression and release pressures at the various heights from the free to solid for both of the spring arrangements.

It may be seen that, owing to an increase in spring capacity, the working range of the Frost spring has been somewhat reduced; that, on release the spring gives out materially less energy than is applied to it, and that a yielding peak of high capacity is available at the end of the travel to absorb undue shocks such as set up by a rolling car. The combination of the Harvey friction spring and A. R. A. standard coils in the same cluster is patented.

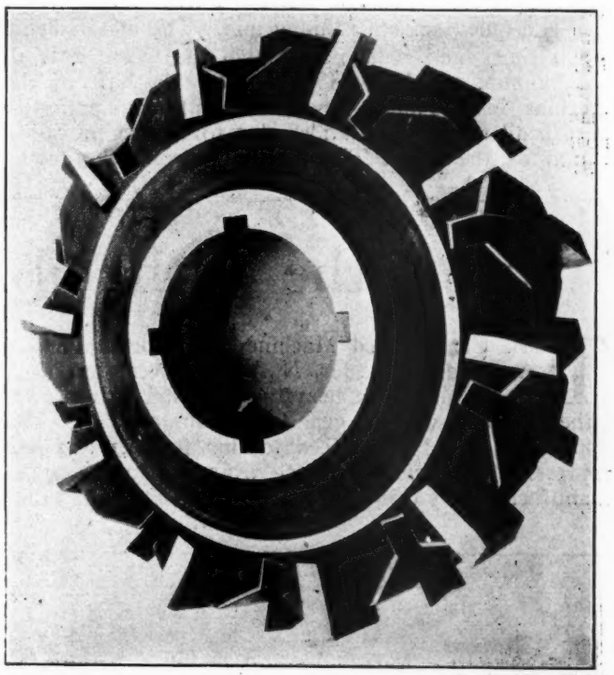
O. K. heavy duty milling cutters

A HEAVIER line of slotting and facing milling cutters has been added to the list of inserted blade milling cutters, manufactured by the O. K. Tool Company, Inc., Shelton, Conn. The O. K. drop forged tapered and serrated high speed steel blade has been made in a wide range of shapes and thicknesses of ¼ in., ⅜ in. and ½ in. New blades of ¾ in. thickness have been developed to take as heavy a cut as any of the latest milling machines will pull. These heavy cutters are inserted in a chrome-nickel steel forged and heat-treated body. Cutters as large as 36 in. in diameter and 4 in. wide with a single rigid body have been built.

The blade, which is tapered and with a serrated back, fits into a corresponding slot in the body. The tapered surface locks the blade securely in the body without the aid of any screws, taper pins or split body construction. The serrations permit the blade to be adjusted for wear. The blades, which are of drop forged, high speed steel, have a superior cutting edge, the forging operation refining the grain structure of the steel. The bodies are also forged and heat treated for similar reasons. The blade is hard and heat resisting while the body is tough and strong.

Any of the standard designs of cutters are made such as slotting cutters, side mills, either straight or angular, half side mills, face mills, etc. A suitable rake and spiral angle, as well as adequate chip clearance, is provided.

Other cutting tools as boring and facing heads, hollow mills, trepanning tools, etc., have found a very useful application of this type of blade.



One of the O. K. heavy duty inserted blade milling cutters

The Racine shear-cut production saw

THE principal development incorporated in the Shear-Cut production saw now manufactured by the Racine Tool & Machine Company, Racine, Wis., is that the saw is progressively drawn or fed into the metal at a certain speed accurately predetermined for each size of stock.

The adjustable screw feeding of the saw blade is accomplished by a positive acting screw. This screw is turned by a cam on the main shaft operating a radius arm with an adjustable lever sliding therein to give feeds as desired by the operator. A range of cutting speeds and feeds are available for cutting such materials as pipe, tubing and all solid metals.

The feed is determined by the size of the stock to be cut and the placing of the feed-adjusting lever in the proper notch for each size of bar. The lever is set by hand. Notches in the radius arm indicate the proper feed for each size of stock. A convenient plate on the machine indicates to the operator the proper speeds and feeds.

The clutch is thrown out automatically and the feeding device is released after the cut is finished by an automatic knockout. This knockout releases the feeding screw which allows the balanced saw guide to be reset in any desired position. This saw guide is so balanced that it holds itself at any desired height, giving the operator free use of both hands in resetting and gaging stock for the next cut. The saw is again started by throwing in the clutch, and feeds itself automatically into the work.

The machine may be furnished with a belt drive, single-speed or with three-speed transmission, or with a motor drive through direct connected worm-gear or silent chain.

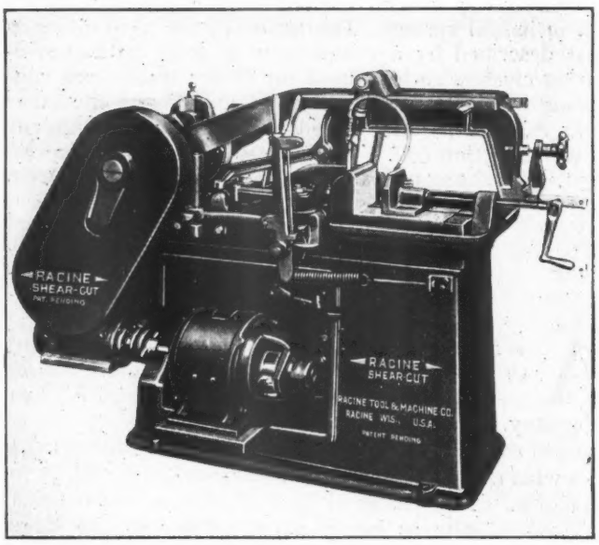
The machine is furnished with a three-speed trans-

mission where it is necessary to cut a variety of metals such as cast iron, tool steel, alloys and other stock of different degrees of hardness.

The three-speed transmission is mounted solidly on the base, providing speeds of 135, 90 an 60 strokes a minute. This transmission is also combined with the worm gear motor drive as a single unit.

The saw frame is fitted with a felt pad in the top and with suitable oil grooves to hold oil for a long period of time providing a continuous oil film for the sliding ways. This felt pad is fed by sight glass feed oiler which regulates the amount of oil and does not allow a surplus of oil to create an untidy appearance. Wick oilers are used at all necessary points so as to feed enough oil to the various bearings to provide ample lubrication without permitting oil to spread over the machine or over the floor.

The motor drive is made in both single speed and three-speed types through enclosed worm gearing which makes a quiet, smooth running unit. The motor, being 1,800 r.p.m. and reducing through the worm gear to a maximum speed of 135 r.p.m. at the shaft of the machine, insures ample power and continuous action to absorb all tendency to knock due to the reciprocating action of the saw. The machine having the motor mounted in the base is compact and occupies a minimum of floor space.



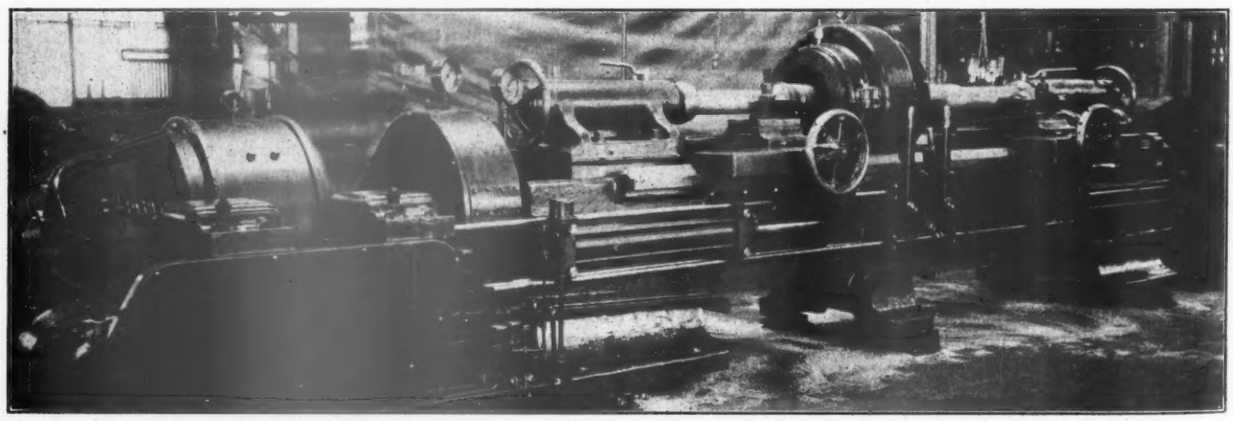
The Racine motor, chain drive metal cutting saw

Axle lathe with oil gear feed to carriage

THE Consolidated Machine Tool Corporation of America, Rochester, N. Y., has recently placed on the market a heavy duty center driven axle lathe, equipped with oil gear feed to the carriages. The application of oil gear feed to this type of machine represents a marked advance over previous designs manufactured by this company, as it eliminates trouble-some feed gearing and provides for operating the carriages by power.

Positive feeding pressure is applied to each tool by oil cylinders attached to the under side of each carriage at the front and back. This arrangement eliminates the twisting strain present in the rack or screw feed designs. The application of feed pressure directly under the tool and held rigidly in balance permits of much heavier cuts and feeds than is possible where feed pressure is transmitted through a train of gears.

Each carriage is provided with adjustable automatic stops. The control levers for setting the rate of feed and for the power traverse of the carriages are located at the center of the machine where they are always within reach of the operator. Power traverse is at the rate of 6 ft. per min. Any feed from zero to ½ in. per revolution is immediately available.



Heavy duty center drive axle lathe equipped with oil gear feed for the carriages

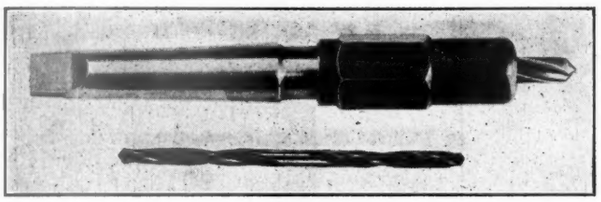
The main drive is by either an adjustable speed motor through a single train of gears or by a constant speed motor through a three-speed gear box. The center driving head is equipped with Sykes herringbone gears. The two oil gear pumps are driven by a 3-hp. constant speed motor.

The machine illustrated is equipped with a 35-hp. adjustable speed motor for especially heavy duty. Ordinary railroad requirements for this machine call for a 25-hp. motor.

Stick-To chucks and double twist drills

THE Specialty Trading Corporation, 551 Fifth avenue, New York, has placed on the market a new type of drill chuck for the purpose of reducing drilling costs. The chuck, which is designated as the Stick-To type, is designed to prevent the breakage of drills and to use up any kind of broken drills. For the latter purpose it grips the twist of the drill without marring or dulling the cutting edge.

The chuck consists of two principal parts: The arbor, or shank, which is hollow at the lower end, and the outer sleeve which is threaded to screw onto the lower end of the arbor. When assembled together, the twist drill is held firmly with the aid of internal taper

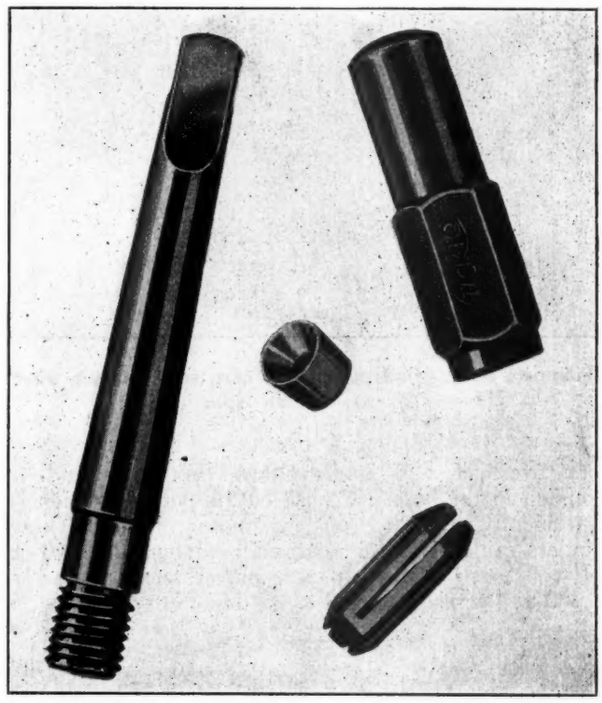


Top—Eight contact points grip the drill in the Stick-To Chuck; Bottom—The double twist drill that can be used in this chuck

surfaces, and a jamb sleeve slitted and beveled at both ends. When the chuck is screwed together, one of these beveled ends is jammed against the tapered surface in the outer sleeve, while the other end is pressed together by a loose interior collar, which is tapered and beveled on the inside at one end. The twist drill is held at two places in the chuck some distance apart providing eight contact points, preventing slippage of drills and giving an excellent alignment.

The projection of the twist drill outside the chuck may be regulated to the depth of the hole or to the most effective and economical free length desired. This feature reduces vibration and breakage.

The chucks may be used for rough as well as precision work. It is recommended for use with the quick change collet system, multiple spindle work, both drilling and tapping as the diameter of the chuck is so small that it will work in very close centers. Its slender form offers better opportunities to get at and watch the drilling. Each chuck has a capacity to take five sizes of drills varying in steps of 1/64 in.



The drill chuck consists of only four parts

The chuck makes it possible to use the Stick-To double twist drills that give two drills in one. When one end of the drill becomes dull, much time can be saved by simply inverting the drill in the chuck and using the other end. The full length of the drill can be consumed satisfactorily as there is no useless shank to be discarded. The Stick-To double twist drills are made of Swedish steels.

Cincinnati heavy duty floor grinders

THE Cincinnati Electrical Tool Company, subsidiary of the R. K. LeBlond Machine Tool Company, Cincinnati, Ohio, has recently added to its line of electric drills, grinders and buffers, 5, 7½ and 10 h.p. heavy duty floor grinders, designed for the heaviest grinding in foundaries, railroad and forge shops.

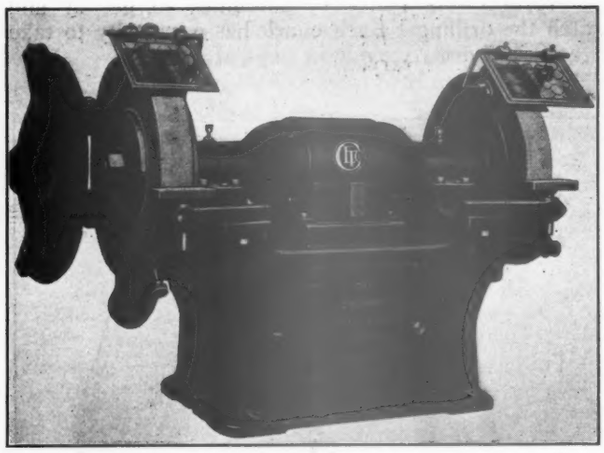
The motors are fully-enclosed and the spindle is mounted on four Timken tapered roller bearings running in oil. Provision has been made for excluding grit and dust from the bearings and the bearing mounting is of the newest Timken type. The bearings are adjustable to wear and as the wear takes place between the cup and the cone of the bearings they can be taken up by means of an adjusting nut.

The wheel guards are of cast steel complying fully with all safety standards. The guards are equipped with exhaust connections and have a four-in. adjustment to wear of wheels. Hinged covers completely enclose the sides of the wheels, flanges and nuts, affording protection to the operator. Non-breakable adjustable eye shields as well as chip breakers are also provided over each grinding wheel. The grinding rests are adjustable and can also be removed entirely on work where they might interfere with the free movement of the operator. The one-piece spindle is of nickel alloy steel, turned and accurately ground to size. The wheel flanges and nuts are machined to be in balance with the spindle, insuring a minimum of vibration.

The abrasive wheels for use in connection with the grinders have a 12-in. bore which not only effects a

saving in the initial cost of the grinding wheels but also reduces the discarded wheel losses to a minimum, due to the extra large bore.

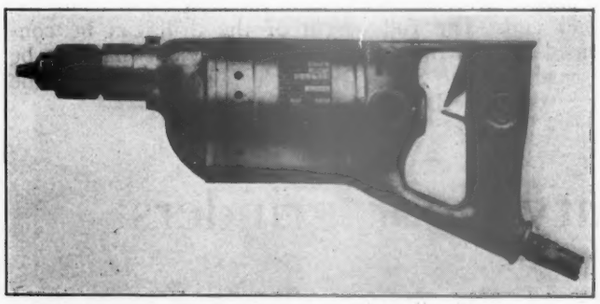
The starter is of the safety type, fully enclosed, with both overload and undervoltage protection and is mounted in the base. A push-button control station is conveniently mounted on the motor frame. These grinders can be had for alternating current, 220-440 or 550 volts, two or three phase, and direct current, 115 or 230 volts.



Cincinnati floor grinder showing cast steel hinged wheel guards thrown open

Electric drills equipped with universal motors

NEW ¼-in. and 5/16-in. heavy duty electric drills and also ¾-in., ⅞-in. and 1-in. heavy duty electric drills have been placed on the market by the Standard Electrical Tool Company, 1938 W. Eighth street, Cincinnati, Ohio.

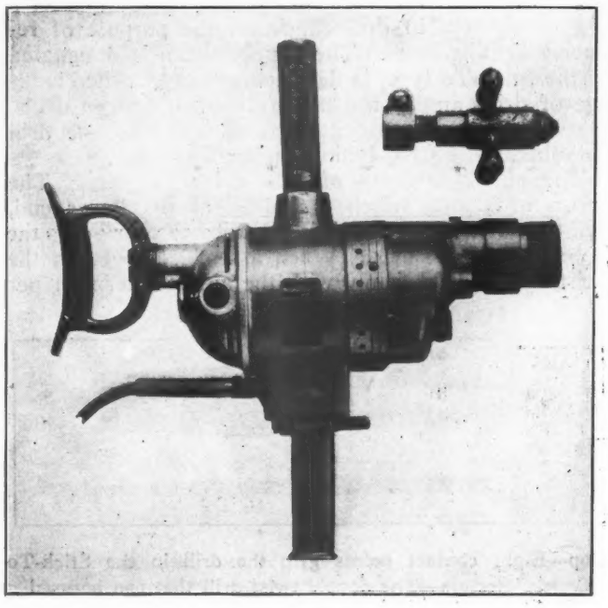


The motor furnished with this drill can be operated either on a.c. or d.c. current

The motors are manufactured by the General Electric Company. They are the universal type which operate on either direct or alternating current. SKF ball bearings are used. The gears are made of chrome-nickel steel, and run in grease. The motor housings are made entirely of aluminum to lighten the weight.

The weight of the ¼-in. drill is 7¾ lb.; the 5/16-in. drill, 8½ lb.; the ¾-in. drill, 23 lb.; the ⅞-in. drill, 24 lb., and the 1-in. drill, 25 lb. The capacities given are for drilling in steel.

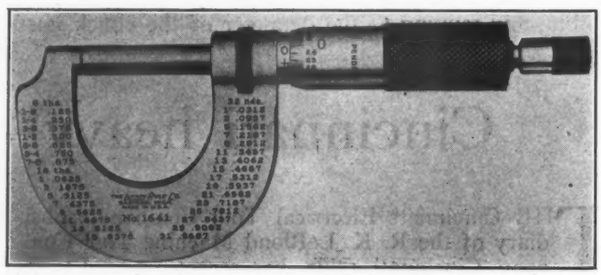
The ¼-in. and 5/16-in. drills have grip handles with the switches mounted therein. The ¾-in., ⅞-in. and 1-in. drills are equipped with Morse taper sockets, spade handles and feed screws.



The Standard ¾-in. portable electric drill

Rapid reading micrometers

THE Lufkin Rule Company, Saginaw, Mich., has added to all of its micrometers the feature of rapid reading graduations. Instead of numbering every five thousandths on the sleeve of the tool, each thousandth is numbered consecutively up to 25, with every five thousandths number showing more prominently. This simplifies the reading and assists much in eliminating mistakes, as it is only necessary to add the figure showing at the reading line on the sleeve to the last twenty-five thousands line showing on the hub o fthe micrometer. It is similar in principle to the readable graduations on steel scales and the instantaneous reading on steel tapes.



A Lufkin micrometer provided with rapid reading graduations

News of the Month

THE HUNGARIAN STATE RAILWAYS has in operation 21 rail motor cars, of which five are of the four-axle 150-hp. type and 16 are of the two-axle 80-90-hp. type. The smaller unit has proved to be generally more economical, particularly where traffic is limited. The fuel consumption of the larger type is rather heavy and about equals in cost that of a small steam locomotive. Therefore a new small type steam locomotive is being constructed for the state railways which, it is expected, will eventually serve as a substitute for the heavier rail motor cars of the two-axle 80-90-hp. type which have been ordered.

Wage increase on the T. & P.

SHOP MECHANICS and apprentices of the Texas & Pacific and the Texas Pacific-Missouri Pacific Terminal Railroad of New Orleans, members of the Association of Mechanical Department Employees, have been granted wage increases of 2 cents and 1 cent per hour respectively under the terms of a new wage agreement negotiated at Dallas, Tex., on March 5. About 1,700 employees of the Texas & Pacific and about 210 employees of the New Orleans terminal are affected by the wage increase.

Brotherhoods want mechanical firebox doors

THE BROTHERHOOD OF LOCOMOTIVE ENGINEERS and the Brotherhood of Locomotive Firemen and Enginemen, in a complaint filed with the Interstate Commerce Commission, ask that the commission adopt a rule requiring that all locomotives be equipped with mechanically operated firebox doors. The complaint says that the chief inspector of locomotives has recommended the adoption of such a rule, that the legislatures of several states including Georgia, Indiana, Iowa, Michigan, New York, Ohio, and Wisconsin have passed laws requiring them, and that some railroads have equipped a large number of their locomotives with them.

300 million for fuel in 1927

CLASS I RAILWAYS of the United States in 1927 expended $310,869,524 for coal and oil used as fuel for road locomotives in freight and passenger service, (charged to operating expenses), according to a statistical report made public by the Interstate Commerce Commission. This compared with $327,465,482 in 1926. In 1927, according to the report, the railways consumed 95,459,840 net tons of coal, at an average cost of $2.66 a ton, as compared with 101,155,412 tons in 1926 at an average cost of $2.63 a ton. They also consumed 2,042,137,055 gallons of fuel oil, slightly less than in the year before, at an average cost of 2.81 cents per gallon, as compared with an average of 2.95 cents the year before. The expense for oil was $57,326,689, as compared with $60,938,230 in 1926.

Railway Mechanical library at Penn State

A UNIQUE COLLECTION of books and periodicals dealing with railway mechanical engineering has been set aside at the library of the Pennsylvania State College, for the use of students and engineers interested in transportation. This collection, known as the Edward Livingston Coster Memorial Library in Railway Mechanical Engineering, was established in 1926 by Mrs. Edward L. Coster in memory of her husband, the late Edward L. Coster, of Katonah, N. Y. Mr. Coster was an engineer of independent means who devoted much time to the analysis of problems in locomotive operation.

It is proposed to add many outstanding technical books pertaining to other phases of transportation and to maintain a complete file of the proceedings of the principal railway mechanical organizations. Contributions of literature from railroad officers will be welcome. Inquiries regarding material available or arrangements for loans may be addressed to Prof. A. J. Wod, head, department of mechanical engineering, or, to the Librarian, Pennsylvania State College, State College, Pa.

Extension of effective dates of various requirements in rules and standards

CIRCULAR No. D. V.-566, issued March 5, 1928, from the office of the secretary of the A.R.A., Mechanical Division, covers the extension of the effective dates of two interchange rules. In Interchange Rule 3, Section (t), paragraph 1, the effective date has been changed to apply to new cars for which orders are placed on or after January 1, 1929, instead of on or after July 1, 1928. Also, the rule is not intended to interfere with the use of trucks now in existence, except that old trucks applied to new cars or new car bodies shall be made to conform to the arch bar standards that are in effect at the date the cars or bodies are built. The Arbitration Committee has been requested to formulate a revision of this rule in accordance with the above intent.

The effective date of Interchange Rule 66 has been extended from May 1, 1928, to January 1, 1929. This extension is made in order to permit the Committee on Lubrication for Cars and Locomotives to revise and bring up to date the standard method for the packing of journal boxes, including renovation of oil and waste. It is expected that a report from this committee will be available for action at the annual meeting in June, 1928.

Rebuilt car rule found unreasonable

AMERICAN RAILWAY ASSOCIATION, Mechanical Division Interchange Rule 112, in so far as it affects settlements to be made for rebuilt freight cars when badly damaged or destroyed on the lines of railroads other than their owners, was found to be unreasonable in a decision made public by the Interstate Commerce Commission on February 16 on a complaint filed by the Bangor & Aroostook. The complaint was based on an interpretation by the Arbitration Committee under which, if any material in the structure above the trucks is reclaimed, the entire car is depreciated, for settlement purposes, from the date of original construction of the unit from which the re-used part was obtained.

In place of the existing rule the commission prescribes a rule containing some modifications of one that was proposed by a special committee of railway mechanical officers.

The findings of the commission's report are as follows:

"The freight cars which have been rebuilt under the sanction of the Interchange Rules and which are now in service will continue to circulate until their interchange is restricted, irrespective of the character of settlement rule which is applied when such units are destroyed on the lines of railroads other than their owners. Hence, as regards equipment rebuilt in the past, it is unlikely that the establishment or nonestablishment of a rebuilt-car settlement rule will materially affect the matter of safety in railway operation. Under instructions to bring in a rebuilt-car rule, the special committee on rebuilt cars, consisting of 10 prominent railroad mechanical department officers, formulated a proposed rule which is apparently designed to effect substantial justice as between car owners and users."

They suggested, in part that, as applied to units reconstructed

in the past, a rebuilt-car settlement rule should be confined to cars in classes A to E-2, and, as regards those reconstructed in the future, only classes from A to D should be recognized.

"We find that as to past and future, a rebuilt freight car is one which the carrier was, is now, or in the future may be required by the accounting rules of the commission to record in equipment-investment account. We further find that for freight cars rebuilt in the future, that portion of the proposed rule formulated by the special committee on re-built cars, which contemplates settlement for cars of classes A to D on basis of 80 per cent of reproduction cost new, less depreciation from date rebuilt, will be reasonable if modified to conform with the foregoing definition of what constitutes a rebuilt car. As to freight cars reconstructed in the past, we find that the present rule is unreasonable, and that for the future a rule which provides for settlement for cars in classes A to D on a basis of 80 per cent of reproduction cost new, less depreciation from date rebuilt, cars of classes E-1 and E-2 on basis of 70 per cent of reproduction cost new less depreciation from date rebuilt, and cars of classes E-3 and E-4 on basis of 60 per cent of reproduction cost new less depreciation from date rebuilt, will be reasonable.

"No order will be entered at this time, but defendants will be expected to modify their rules to conform with our conclusions herein. If this is not done within a reasonable period, complainants may bring the matter to our attention for appropriate action."

Wrong brake levers cause cast-iron wheel failures

AT THE REQUEST of the General Committee of the Mechanical Division of the American Railway Association in connection with failures of cast iron wheels, the Committee on Brakes and Brake Equipment has made an investigation to determine the braking ratios existing on freight cars. The following statements as to the results of this investigation are taken from Mechanical Division circular No. D. V. 567. This investigation, which included measurement of brake levers on a large number of cars disclosed that, regardless of the braking ratio specified, the actual brake shoe pressure, resulting from the application of incorrectly proportioned levers—all levers were not standard for the cars—ranged from an undesired minimum to an almost prohibitive maximum. This was particularly true of stock, tank and refrigerator cars and is undoubtedly contributing largely to the failure of cast iron wheels.

Means for readily identifying the proper brake levers for all classes of cars, both home and foreign, are in course of preparation by the Mechanical Division. Until such time as the results of these developments are available and proper means of lever identification is decided upon, it is recommended that individual carriers use every means available to check levers on home cars, to see that the existing leverage ratios conform to the standard for each car.

Strictness of the safety appliance law

THAT THE SAFETY APPLIANCE LAW requires a railroad, in its maintenance of car-couplers, air brakes, etc., to adhere constantly to standards of absolute perfection, is well known to those who have had occasion to keep acquainted with the utterances of the courts on the subject. Perfection or nothing! No such thing as Chief Justice White's "rule of reason" ever occurred, to the framers of this statute, as a provision suitable to be included. In a recent decision of the Circuit Court of Appeals, Eighth Circuit, the beauties of this statute are brought out in plain language. The case was one of the government against the Southern Pacific (23 Fed.-2d-61) where a coupler of a freight car failed at or before reaching Duran, N. M. The defect was not discovered by any member of the train crew until the train reached Pastura, 37 miles north of Duran. There, the trouble was discovered by a brakeman and repairs were made in a minute or two; but the fact that the car had been hauled 37 miles after the fault had developed, made the company liable for violation of law and a penalty of $100 was imposed. The court holds that the railroad must, at its peril, discover a defect as soon as it occurs. If a trainman had discovered the defect at Duran, it would then have been lawful to move the car to a repair point. The peculiarity of the case is that two government inspectors had discovered the defect at Duran, and apparently this discovery is what brought the case into court. These inspectors did not notify the train crew and, says the court, it was not their duty to do so.

Dr. W. F. M. Goss

DR. WILLIAM F. M. GOSS, former professor of railway engineering and dean of the College of Engineering at the University of Illinois, died on March 23 at the Waldorf Astoria Hotel, New York. Dr. Goss was born at Barnstable, Mass., on October 7, 1859, and was a graduate of the Massachusetts Institute of Technology, Boston. In 1879 he organized a department of practical mechanics at Purdue University, serving as instructor of practical mechanics until 1883 when he became professor of experimental engineering, dean of the schools of engineering and director of engineering in the laboratory. He subsequently was dean of the college of engineering, director of the school of railway engineering and administration, and professor of railway engineering at the University of Illinois until 1917, also director of engineering at the experimental station from 1909 to 1917. During the latter year he was appointed president of the Railway Car Manufacturers' Association at New York, from which position he retired in 1925. Dr. Goss was a member of the jury of awards at the Chicago Exposition in 1893; chairman of the advisory committee of the Pennsylvania charged with testing locomotives at the St. Louis Exposition in 1904, and chief engineer of the Committee of Investigation on Smoke Abatement and Electrification of Railway Terminals in Chicago from 1913 to 1915. He was a member of many technical societies and had served as president of the American Society of Mechanical Engineers, Society for the Promotion of Engineering Education, and the Western Railway Club. He was the author of technical books, including Bench Work in Wood, 1890; Locomotive Sparks, 1902; Locomotive Problems, 1907; High Steam Pressures in Locomotive Service, 1907; Superheated Steam in Locomotive Service, 1910, and many scientific reports and papers.

Dr. W. F. M. Goss

Discussion of boiler pitting—Dispatching

The Western Railway Club program for the meeting of March 19 included the presentation of two papers: "Electrochemical method for the prevention of locomotive boiler corrosion" by L. O. Gunderson, chemical engineer, Chicago & Alton, and "The dispatcher controlled signal system for Train Operation" by W. B. Rudd, Union Switch & Signal Co. Mr. Gunderson explained with the assistance of lantern slides the theory and application of a system of pitting prevention which has been developed on the Chicago & Alton. Mr. Gunderson estimated that the pitting of tubes and boiler sheets is costing the railroads from 12 to 15 million dollars annually.

The discussion following Mr. Gunderson's paper was brief but revealed much curiosity concerning the use of arsenic in water treating work, the principal point in this discussion coming from Fred Horstmann, Dearborn Chemical Company, who said that arsenic has previously been used successfully in pitting prevention without assistance from other means.

Mr. Rudd had on hand an example of a train dispatcher's machine and an automatic train graph recording device which

he explained in the course of his talk. Following this paper, a motion picture was presented explaining in detail the operation of the dispatcher control system.

I. C. C. examiner recommends curtains in cab

THE INTERSTATE COMMERCE COMMISSION has made public a proposed report by Special Examiner John L. Rogers recommending that the commission find that the safety of employees and travelers upon railroads requires that in certain territories in the northern part of the country steam locomotives and tenders have suitable cab curtains; that unnecessary or excessive openings about locomotive cabs be closed during the winter months; that oil-burning locomotives do not take air into the firebox from the interior of the cab; and that steam locomotives used in road service have a suitable storm window attached to side cab windows.

The report was submitted in the case arising on a complaint filed by the Railroad Commission of Wisconsin in which the commissions of several other states and the Brotherhood of Locomotive Engineers and the Brotherhood of Locomotive Firemen and Enginemen intervened. Hearings have been held at various places. The report recommends that Rule 116 of the rules and instructions for the inspection and testing of steam locomotives and tenders be amended by adding the requirements proposed, effective November 1, 1928. The proposed amendments provide that each locomotive used in Colorado, Connecticut, Delaware, District of Columbia, Idaho, Illinois, Indiana, Iowa, Kansas, Kentucky, Maine, Maryland, Massachusetts, Michigan, Minnesota, Missouri, Montana, Nebraska, New Hampshire, New Jersey, New York, Nevada, North Dakota, Ohio, Oregon, Pennsylvania, Rhode Island, South Dakota, Utah, Vermont, Virginia, Washington, West Virginia, Wisconsin, Wyoming and part of California, except deckless locomotives and locomotives equipped with a vestibule cab, shall have suitable doors, or a suitable roll or slide back curtain of sufficient length and width to cover the opening in rear wall of cab. From November 1 to April 1 the locomotives not equipped with a vestibule cab are also required to have suitable side curtains, and in the states named except Maryland, Virginia, Kentucky, California and the District of Columbia to have cab hood curtains.

"It is only fair to state," the report says, "that several of the carriers have for a considerable period provided all the protective equipment covered by the proposed rules. Other carriers have provided the greater part of it. The principal effect of the proposed rules as to these carriers will be to secure better maintenance of the equipment so that it will best serve the purpose for which it is applied." It adds that the proposed rules should be regarded as minimum requirements which are not intended to take care of the most extreme conditions.

Meetings and Conventions

June exhibit at Atlantic City

At a meeting of the Exhibit Committee of the Railway Supply Manufacturers' Association held at Pittsburgh, Pa., March 22 and 23, assignments of 127,000 sq. ft. of exhibit space were made to 321 exhibitors for the exhibit which will be held on Young's Million Dollar Pier at Atlantic City, N. J., June 20 to 27, inclusive, during the conventions of the Mechanical, Purchases and Stores, and Motor Transport Division of the American Railway Association. The total space available this year is 142,270 sq. ft., of which 48,000 sq. ft. is located in Marine Hall, the new structure which is being provided on the ocean side of the boardwalk immediately adjoining, and directly connected to the boardwalk end of the pier.

The Mechanical Division meeting will be held from June 20 to 27, inclusive, in the convention hall on Young's Million Dollar Pier; the Purchases and Stores Division will meet in Vernon Hall, Haddon Hall Hotel, June 20 to 22, inclusive, and the Motor Transport Division meeting will be held at the Traymore Hotel, June 21 to 23, inclusive.

The following list gives names of secretaries, dates of next or regular meetings and places of meeting of mechanical associations and railroad clubs.

AIR-BRAKE ASSOCIATION.—T. L. Burton, 165 Broadway, New York. Next meeting May 1-4, Book-Cadillac hotel, Detroit, Mich.

AMERICAN RAILWAY ASSOCIATION DIVISION V.—MECHANICAL.—V. R. Hawthorne, 431 South Dearborn St., Chicago. Next meeting June 20 to 27, 1928, inclusive, Atlantic City, N. J.

DIVISION V.—EQUIPMENT PAINTING SECTION.—V. R. Hawthorne, Chicago. Next meeting Windsor hotel, Montreal, September 11-13.

DIVISION VI.—PURCHASES AND STORES.—W. J. Farrell, 30 Vesey St., New York. Next meeting June 20-22, Atlantic City, N. J.

AMERICAN RAILWAY TOOL FOREMEN'S ASSOCIATION.—G. G. Macina, 11402 Calumet Ave., Chicago. Annual convention Hotel Sherman, Chicago, August 29-31, 1928.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.—Calvin W. Rice, 29 W. Thirty-ninth St., New York. Railroad Division, Marion B. Richardson, associate editor, *Railway Mechanical Engineer*, 30 Church St., New York. Next meeting, April 17, the Engineering Societies Building, 29 West 39th Street, New York. Paper on performance records of oil-engine locomotives, by Herman Lemp, consulting engineer, Ingersoll-Rand Company. Joint meeting with the Oil and Gas Power Division.

AMERICAN SOCIETY FOR STEEL TREATING.—W. H. Eiseman, 4600 Prospect Ave., Cleveland, Ohio.

AMERICAN SOCIETY FOR TESTING MATERIALS.—C. L. Warwick, 1315 Spruce St., Philadelphia, Pa. Annual meeting June 25-29, Chalfonte-Haddon hotel, Atlantic City, N. J.

AMERICAN WELDING SOCIETY.—Miss M. M. Kelly, 29 West Thirty-ninth St., New York.

ASSOCIATION OF RAILWAY ELECTRICAL ENGINEERS.—Joseph A. Andrucetti, C. & N. W., Room 411, C. & N. W. Station, Chicago, Ill. Annual meeting, October 23-26, Hotel Sherman, Chicago.

CANADIAN RAILWAY CLUB.—C. R. Crook, 129 Charon St., Montreal, Que. Regular meetings, second Tuesday in each month, except June, July and August, at Windsor Hotel, Montreal, Que. Next meeting April 10 at 8:15 p. m. Paper on television will be presented by Dr. R. W. King, Bell Telephone Laboratories, New York. Illustrated by lantern slides.

CAR FOREMEN'S ASSOCIATION OF CHICAGO.—Aaron Kline, 626 N. Pine Ave., Chicago, Ill. Regular meeting second Monday in each month, except June, July and August. Great Northern Hotel, Chicago. Next meeting April 9. Paper on proper loading of cars will be presented by M. E. Fitzgerald, general inspector, Chicago & Eastern Illinois. Stereopticon views.

CAR FOREMEN'S ASSOCIATION OF ST. LOUIS.—A. J. Walsh, 5874 Plymouth Apt. 18, St. Louis, Mo. Regular meeting first Tuesday in each month, except June, July and August, at Broadview Hotel, East St. Louis, Ill. The next meeting April 3 at 8 p. m. Paper on Interchange Problems will be presented by C. J. Nelson, Chief Interchange Inspector, Chicago.

CAR FOREMEN'S CLUB OF LOS ANGELES.—J. W. Krause, 514 East Eighth St., Los Angeles. Cal. Meeting second Friday of each month in the Pacific Electric Club building, Los Angeles, Cal.

CENTRAL RAILWAY CLUB.—H. D. Vought, 26 Cortlandt St., New York. Regular meetings second Tuesday each month, except June, July and August, at Hotel Statler, Buffalo. Next meeting April 12, 8 p. m. Paper on Installation and Maintenance of Concrete Roadbed will be presented by Paul Chipman, Valuation Engineer, Pere Marquette, Detroit, Mich.

CHIEF INTERCHANGE CAR INSPECTORS' AND CAR FOREMEN'S ASSOCIATION.—(See Railway Car Department Officers' Association.)

CINCINNATI RAILWAY CLUB.—D. R. Boyd, 3328 Beekman St., Cincinnati. Regular meeting second Tuesday, February, May, September and November.

CLEVELAND RAILWAY CLUB.—F. L. Frericks, 14416 Adler Ave., Cleveland, Ohio. Meetings first Monday each month, except July, August and September, at Hotel Hollenden, East Sixth and Superior Ave., Cleveland. Next meeting April 2 at 8 p.m. Paper on the prevention of rust on steel will be presented by T. J. Fay, president, the Fay Metal Patch Company.

INTERNATIONAL RAILROAD MASTER BLACKSMITHS' ASSOCIATION.—W. J. Mayer, Michigan Central, 2347 Clark Ave., Detroit, Mich. Next meeting Hotel Sherman, Chicago, August 21-22, 1928.

INTERNATIONAL RAILWAY FUEL ASSOCIATION.—L. G. Plant, Railway Exchange, 80 E. Jackson Boulevard, Chicago. Next meeting Chicago, May 7-11, 1928.

INTERNATIONAL RAILWAY GENERAL FOREMEN'S ASSOCIATION.—William Hall, 1061 W. Wabash Ave., Winona, Minn. Annual convention Hotel Sherman, Chicago, September 4-7, 1928.

LOUISIANA CAR DEPARTMENT ASSOCIATION.—L. Brownlee, 3212 Delachaise street, New Orleans, La. Meetings third Thursday in each month.

MASTER BOILERMAKERS' ASSOCIATION.—Harry D. Vought, 26 Cortlandt St., New York. Annual meeting Cleveland, Ohio, May 22-25.

NEW ENGLAND RAILROAD CLUB.—W. E. Cade, Jr., 683 Atlantic Ave., Boston, Mass. Regular meeting second Tuesday in each month, excepting June, July, August and September, Copley-Plaza Hotel, Boston. Next meeting April 10. Paper on the railroad's side of grade crossing accidents will be presented by A. H. Rudd, chief signal engineer, Pennsylvania Railroad.

NEW YORK RAILROAD CLUB.—H. D. Vought, 26 Cortlandt St., New York. Meetings third Friday in each month, except June, July and August, at 29 West Thirty-ninth St., New York. Next meeting April 20. Another Baldwin night.

PACIFIC RAILWAY CLUB.—W. S. Willner, 64 Pine St., San Francisco, Cal. Regular meetings, second Tuesday of each month in San Francisco and Oakland, Cal., alternately.

RAILWAY CAR DEPARTMENT OFFICERS' ASSOCIATION.—A. S. Sternberg, Belt railway, Clearing Station, Chicago.

RAILWAY CLUB OF GREENVILLE.—Paul A. Minnis, Bessemer & Lake Erie, Greenville, Pa. Meeting last Friday of each month, except June, July and August.

RAILWAY CLUB OF PITTSBURGH.—J. D. Conway, 515 Grandview Ave., Pittsburgh, Pa. Regular meeting fourth Thursday in month, except June, July and August. Fort Pitt Hotel, Pittsburgh, Pa.

ST. LOUIS RAILWAY CLUB.—B. W. Frauenthal, M. P. O. Drawer 24, St. Louis, Mo. Regular meetings, second Friday in each month, except June, July and August. Next meeting April 13 at 8 p. m. Paper on the railroad situation today will be presented by Col. Fred W. Green, vice-president, St. Louis-Southwestern. Election of officers.

SOUTHERN AND SOUTHWESTERN RAILWAY CLUB.—A. T. Miller, P. O. Box 1205 Atlanta, Ga. Regular meetings third Thursday in January, March, May, July, September and November. Annual meeting third Thursday in November. Ansley Hotel, Atlanta, Ga.

SOUTHWEST MASTER CAR BUILDERS' AND SUPERVISORS' ASSOCIATION.—E. H. Weigman, master car builder, the Kansas City Southern, Pittsburg, Kan. Annual meeting August 4, 5 and 6 at Galveston, Tex.

TEXAS CAR FOREMEN'S ASSOCIATION.—A. I. Parish, 106 West Front St., Fort Worth, Tex. Regular meetings first Tuesday in each month. Terminal Hotel bldg., Fort Worth, Tex.

TRAVELING ENGINEERS' ASSOCIATION.—W. O. Thompson, 1177 East Ninety-eighth St., Cleveland, Ohio. Annual meeting Hotel Sherman, Chicago, October 2 to 5, inclusive.

WESTERN RAILWAY CLUB.—W. J. Dickinson, 189 West Madison St., Chicago. Regular meetings, third Monday in each month, except June, July and August.

Supply Trade Notes

The U. S. Electrical Tool Company has opened a branch office at 205 University Building, Syracuse, N. Y., in charge of H. N. Kelsey.

James R. White, vice-president of Rickard & Co., industrial advertising agents, resigned to become secretary to Jenkins Brothers, valve manufacturers, New York.

H. S. La Barge, manager of railway sales of the Glidden Company, with headquarters at Cleveland, Ohio, has been transferred to St. Louis, Mo.

Walter B. Leach, president and general manager of the Hunt-Spiller Manufacturing Corporation, Boston, Mass., died after a prolonged illness at his home in Brookline, Mass., on March 13.

Myron F. Westover, secretary of the General Electric Company for the past 34 years, has retired and William W. Trench, assistant secretary, has been elected secretary to succeed him.

P. P. Barrett, has been appointed representative for the Reading Iron Company, Reading, Pa., in the Cincinnati territory. Mr. Barrett's headquarters are at Indianapolis, Ind.

John D. Swift, president of the Eagle Pitcher Lead Company, Cleveland, Ohio, has been elected chairman of the board and will be succeeded by A. E. Dendelain, vice-president with headquarters at Chicago.

A. L. Whipple, who has been a representative of the Locomotive Stoker Company for the past eight years, is now a district sales manager for the Standard Stoker Company, Inc., with offices at 350 Madison Avenue, New York City.

The Standard Steel Car Company has purchased the Illinois Car & Manufacturing Company, Chicago. P. H. Joyce, president of the Illinois Car & Manufacturing Company has been elected vice-president of the Standard Steel Car Company.

A. L. Roberts, formerly with the railroad sales department of the Central Alloy Steel Corporation, Massillon, Ohio, has joined the development and research department of the International Nickel Company, New York, and will devote his time to railroad development work.

H. G. Mastin, formerly with the Locomotive Stoker Company has become associated with the Pantasote Company, Inc., New York, as assistant to W. A. Lake. Mr. Mastin before serving with the Locomotive Stoker Company was for some years with the New York, Ontario & Western.

F. O. Schramm, assistant secretary of the Pressed Steel Car Company, at New York, has been appointed also assistant general sales manager for the eastern territory, and Frank L. Johnson, sales engineer, has been appointed assistant general sales manager for the western territory, with headquarters at Chicago.

The Executive Offices of the Worthington Pump & Machinery Corporation, also its export sales department and New York district sales department have been removed from 115 Broadway to 2 Park avenue, New York City. The general sales office and the advertising department have been removed to its plant at 421 Worthington avenue, Harrison, N. J.

C. I. Auten has been appointed vice-president in charge of sales in the standard building division of the Truscon Steel Company, Youngstown, Ohio; M. T. Clark has been appointed vice-president in charge of sales of the steel window division, and C. D. Loveland, formerly manager of the Pittsburgh district, has been appointed vice-president, with headquarters at Newark, N. J.

William B. Updegraff has been elected vice-president in charge of sales, of the Watson-Stillman Company, New York. For the last 15 years Mr. Updegraff has been engaged in various engineering and sales capacities with this company. As a graduate of Harvard University, he has been actively interested in the Harvard Engineering Society. He is also a member of the American Society of Mechanical Engineers.

Roy A. Phelps has been appointed district manager of the railway sales department of E. I. DuPont, de Nemours & Co., Inc., with headquarters at Parlin, N. J., handling the company's business in the southeastern territory, and Carl F. Gehlen has been appointed assistant to manager railway sales department. Mr. Phelps was born on October 22, 1895, at Chicago. He attended public school and high school at Dayton, Ohio, and upon graduation entered the service of the Dayton Tire & Rubber Company, Dayton. Mr. Phelps left the Dayton Tire & Rubber Company in April, 1917, to enter the service of the U. S. Army, during the period of the late war. Upon his discharge from the army in May, 1919, he went with the sales department of the Sherwin-Williams Company, handling sales for the railway, marine and petroleum division. On January 1, 1926, he was appointed assistant to the manager of the railway sales department of the E. I. DuPont de Nemours & Co., Inc., which position he held until his appointment as above noted.

Roy A. Phelps

The Hammond Bolt & Nut Company, Hammond, Ind., has bought the bolt, nut and rivet department formerly owned and operated by The Illinois Car & Manufacturing Co. The officers of the company are as follows: M. J. McDonough, president, E. M. Joyce, vice-president, M. L. Hunt, treasurer and Charles Aaron, secretary. The company will be operated under practically the same management as when this department was owned and operated by The Illinois Car & Manufacturing Co.

The Shaw Crane-Putnam Machine Company, Inc., a subsidiary of Manning, Maxwell & Moore, Inc., has purchased the Lamb & Nash line of sheet metal machines. These machines, which include a squaring shear and rotary gang slitting machines for shearing tin plate, hot mill sheets, brass, copper, aluminum and all classes of cold-rolled steels, will, in the future, be manufactured at the Putnam Works of the Shaw Crane-Putnam Company at Fitchburg, Mass.

The Detroit Steel Products Company, Detroit, Mich., has opened a factory branch at 1740 East Twelfth Street, Cleveland, Ohio. S. M. Hathaway, is district manager; H. K. Strock and K. E. Carr will handle industrial sales; W. G. Brown and A. F. Butler will have charge of casements and basement windows; C. Smallwood and W. P. Scheuerman will be in charge of estimating and engineering service and O. H. Scheppan and A. M. Gordon will be in charge of erection service.

Thomas B. Kirby, organizer and president of the Kirby Equipment Company from 1900 until his retirement in 1916, died on February 18, at Culver City, Cal. He entered railroad service with the Lake Shore & Michigan Southern (now a part of the New York Central) in the shops at Adrian, Mich., about 1870. Later he was transferred to Chicago where he was division master car builder for several years. He resigned from this position to become superintendent of the car department of Armour & Company and later entered the employ of the Lappin Brake Shoe Company. He resigned from the latter company about 1900 to organize the Kirby Equipment Company.

Trade Publications

LATHES AND BORERS.—Specifications for the Bullard driving box borer and facer and the 64-in. spiral drive turret lathe are contained in illustrated bulletins issued by the Bullard Machine Tool Company, Bridgeport, Conn.

SMALL TOOLS.—Taps, dies, screw plates and reamers are the principal tools listed in catalogue No. 19 issued by Butterfield & Company, Derby Line, Vt. Tables of dimensions and general information is contained in a fifth section of the booklet.

SMALL TOOLS.—The English and metric sizes of taps, dies, milling cutters and reamers are each covered in separate sections of a 592-page catalogue, No. 12, issued by the Pratt & Whitney Company, Hartford, Conn.

PIPE THREADING AND CUTTING MACHINERY.—Illustrated catalogue H. of D. Saunders' Sons, Atherton street, Yonkers, N. Y., describes a complete line of pipe threading and cutting machinery and steam and gas fitters' tools.

ELECTRIC DRILLS.—The Temco Electric Motor Company, Leipsic, Ohio, has published a leaflet showing in cross-sectional form the principal constructional features of its Temco portable electric drills. Ball thrust bearings are used in these drills.

HIGH SPEED AND CARBON STEEL TOOLS.—Twist drills, reamers, cutters, hobs, and special tools are among the high speed steel and carbon steel tools displayed in catalogue No. 14 issued by the National Twist Drill & Tool Company, Detroit, Mich.

VISES.—The Rock Island Manufacturing Company, Rock Island, Ill., has issued catalogue No. 40 descriptive of its line of vises which have been designed to meet varied wood or metal working requirements.

"FLEXITALLIC" GASKETS.—Complete information for ordering "Flexitallic" gaskets for pipe flanges, tube caps, and manholes is given in the illustrated folder and price list issued by the Flexitallic Gasket Company, Camden, N. J.

MILLING MACHINES.—The new 36-page catalogue of the Brown & Sharpe Mfg. Company, Providence, R. I., features the Nos. 2A and 3A Standard universal and the Nos. 2B and 3B Standard plain milling machines.

WOODWORKING MACHINES.—Portable machines for woodworkers are illustrated and described in catalogue No. 403-A issued by J. D. Wallace & Company, 134 South California Avenue, Chicago, Ill.

GEAR AND MILLING CUTTERS.—The Union Twist Drill Company, 62 Reade street, Athol, Mass., in catalogue "L" describes tools for hob, cutter, drill and reamer work, each of these tools being dealt with in a separate section.

OIL BURNERS AND PREHEATERS.—Two new bulletins, descriptive of oil burners, preheaters and acetylene generators, have been issued by the Alexander Milburn Company, Baltimore, Ohio. These are bulletins Nos. B-200C and B-200D, respectively.

ARMSTRONG TOOLS.—The Armstrong Bros. Tool Company, 317 North Francisco avenue, Chicago, illustrates and describes in catalogue B-27 toolholders, pipe tools, ratchet drills, drop forged wrenches, etc. Prices also are given.

OPEN-SIDE PLANERS.—The Cleveland open-side planer is described and illustrated in a four-page bulletin issued by the Cleveland Planer Company, 3148 Superior avenue, N. E., Cleveland, Ohio. Specifications also are given.

MONARCH LATHES.—The application of Precision type, Timken tapered roller bearings to the spindles of Monarch lathes is described in Bulletin No. 6 issued by the Monarch Machine Tool Company, Sidney, Ohio. These lathes are built in sizes from 14 in. to 30 in. inclusive.

Personal Mention

General

W. Y. CHERRY has been appointed superintendent of motive power of the Long Island, with headquarters at Richmond Hill, N. Y.

R. W. WRAY, master mechanic of the Pennsylvania at West Philadelphia, Pa., has been promoted to superintendent of motive power of the Lake Division, with headquarters at Cleveland, Ohio, succeeding W. Y. Cherry.

JOHN A. COOPER, formerly general supervision of locomotive operation of the Erie at Meadville, Pa., has been appointed district road foreman and fuel supervisor, western district, with headquarters at Meadville.

JAMES CUNNEEN, formerly general supervisor of locomotive operation of the Erie at Hornell, N. Y., has been appointed district road foreman and fuel supervisor of the New York and Eastern districts, with headquarters at Hornell.

H. J. HADDEN, purchasing agent of the Chicago, Springfield & St. Louis, at Springfield, Ill., has been appointed assistant to the general manager of that road and of the Jacksonville & Havana, with the same headquarters.

THE ERIE has abolished the positions of superintendent of locomotive operation and general supervisor of locomotive operation. T. F. Howley, formerly superintendent of locomotive operation, with headquarters at New York City, has been appointed supervisor of fuel and locomotive operation, with headquarters at the same point.

CURTIS M. YOHE, purchasing agent of the Pittsburgh & Lake Erie at Pittsburgh, Pa., has been appointed assistant to the president of the New York Central Lines, with headquarters at the same point. Mr. Yohe was born on September 22, 1887, at Connellsville, Pa., and was graduated from Cornell University in 1910. He entered railway service with the Pittsburgh & Lake Erie in 1913 as a clerk in the purchasing department at Pittsburgh. In 1920 Mr. Yohe became purchasing agent.

Master Mechanics and Road Foremen

R. P. BLAKE, master mechanic at the Mississippi Street shops of the Northern Pacific at St. Paul, Minn., has been transferred to Spokane, Wash., to succeed G. F. Egbers.

J. B. NEISH has returned as master mechanic at the Mississippi Street shops of the Northern Pacific at St. Paul, Minn. Mr. Neish had been on a leave of absence.

J. D. COUSINS has been appointed road foreman of engines of the Long Island, with headquarters at Jamaica, N. Y., succeeding J. B. Ward, retired.

H. J. W. KLEINE has been appointed assistant master mechanic of the Pittsburgh division of the Pennsylvania, with headquarters at Conemaugh, Pa.

THE JURISDICTION of H. G. Kastlin, master mechanic of the Chicago, Burlington & Quincy at Creston, Iowa, has been extended to include the West Ottumwa division.

THE JURISDICTION of G. P. Trachta, master mechanic of the Chicago, Burlington & Quincy at Galesburg, has been extended to include the East Ottumwa division.

H. C. TURNER, assistant master mechanic of the Chicago, Burlington & Quincy at Burlington, Iowa, now has jurisdiction over the East Ottumwa and Galesburg divisions.

THE JURISDICTION of M. J. Brown, master mechanic of the Chicago, Burlington & Quincy, with headquarters at Chicago, has been extended to include the Aurora division and the Eola repair track.

J. J. MELLEY, master mechanic of the Missouri-Kansas-Texas, with headquarters at Parsons, Kans., has resigned to become assistant to the president of the Viloco Railway Equipment Company, Chicago.

G. F. EGBERS, master mechanic of the Northern Pacific at Spokane, Wash., has been promoted to general master mechanic, with headquarters at Livingston, Mont., succeeding B. P. Johnson.

W. A. KELLY, master mechanic of the Chicago, Burlington & Quincy at Ottumwa, Iowa, has been appointed assistant master mechanic with jurisdiction over the West Ottumwa and Creston divisions and with headquarters at Ottumwa.

E. J. CYR, formerly assistant master mechanic of the Chicago, Burlington & Quincy at Galesburg, Ill., has been appointed assistant master mechanic on the Chicago and Aurora divisions, with headquarters at Aurora, Ill. The office of master mechanic at Aurora, has been abolished.

W. J. JOHNSTON, traveling engineer on the Iowa & Dakota division of the Chicago, Milwaukee, St. Paul & Pacific, with headquarters at Mason City, Iowa, has been appointed acting master mechanic of that division, with headquarters at the same point.

B. P. JOHNSON, general master mechanic of the Northern Pacific, with headquarters at Livingston, Mont., has been promoted to mechanical superintendent of the Eastern lines, with headquarters at St. Paul, Minn., succeeding T. J. Cutler, who has retired on pension because of ill health.

EDWARD G. BOWIE, who has been appointed master mechanic of the Algoma district of the Canadian Pacific, with headquarters at London, Ont., was born at Winnipeg, Man., on August 20, 1892. In May, 1907, he became junior clerk in the office of the freight traffic manager of the Canadian Pacific at Winnipeg. He began his apprenticeship in May, 1908, and from August, 1912, until September, 1914, served as a machinist at Winnipeg and other points on the Western Lines. In October, 1914, he became clerk to the master mechanic at Calgary, Alta. During 1915 he was employed successively as a machinist at the Angus shops, Montreal; dynamometer car operator, Eastern Lines, and assistant locomotive foreman at Ottawa. In May, 1916, he was transferred to Outremont, Montreal, where he was subsequently promoted to locomotive foreman. He was transferred as locomotive foreman to Sherbrooke, Que., in November, 1916, and to Smiths Falls, Ont., in May, 1917. In June, 1918, he was appointed general foreman at McAdam, N. B.; in April, 1920, division master mechanic at Brownville, Me., and in July, 1923, division master mechanic at Schreiber, Ont. From July, 1923, until his appointment as master mechanic of Algoma district, Mr. Bowie had been master mechanic of the London division.

Shop and Enginehouse

J. J. MCGOWAN has been appointed general foreman of the Missouri Pacific, with headquarters at Coffeyville, Kan.

F. W. BURCH has been appointed general foreman of the Missouri Pacific, with headquarters at Gale, Ill.

C. Y. THOMAS, supervisor of apprentices of the Kansas City Southern at Pittsburg, Kan., has been promoted to night enginehouse foreman, with headquarters at Port Arthur, Tex.

W. J. BARLOW has been appointed supervisor of apprentices of the Kansas City Southern, with headquarters at Pittsburg, Kan., succeeding C. Y. Thomas.

Car department

JOHN G. HAYES, car inspector foreman of the St. Louis-San Francisco, has been appointed coach shop foreman, with headquarters at Springfield, Mo., succeeding J. E. Roberts, resigned.

S. P. ENSLEN, traveling car inspector of the St. Louis-San Francisco, has been appointed car inspector foreman, with headquarters at Springfield, Mo., succeeding John G. Hayes.

R. W. ROSE, traveling A. R. A. inspector at Pittsburg, Kan., has been appointed car foreman of the Kansas City Southern, with headquarters at Port Arthur, Tex.

W. KYNER, car foreman of the Atchison, Topeka & Santa Fe at Newton, Kan., has been transferred to Wichita, Kan., succeeding Brint Watt.

C. H. WALTERS, apprentice instructor of the Atchison, Topeka & Santa Fe, has been promoted to car foreman, with headquarters at Newton, Kan., succeeding W. Kyner.

A. S. MCWATERS, repair track foreman of the Nashville, Chattanooga & St. Louis, has been promoted to car foreman and wrecking master, with headquarters at Bruceton, Tenn.

BRINT WATT, car foreman of the Atchison, Topeka & Santa Fe at Wichita, Kan., has been appointed general car foreman, with headquarters at Newton, Kan., succeeding H. N. Calderwood, deceased.

J. A. TRUESDALE, who has been car foreman of the North Western division of the Chicago Great Western at St. Paul, Minn., has been appointed chief joint interchange inspector at Minneapolis and St. Paul, succeeding E. R. Campbell, retired.

Stores Department

E. H. AUSTIN, storekeeper of the Seaboard Air Line at Wildwood, Fla., has been transferred to Tampa, Fla.

F. B. LEWIS has been appointed storekeeper of the Seaboard Air Line, with headquarters at Wildwood.

H. J. WADE has been appointed road foreman of engines at Kansas City, succeeding N. Nissen.

A. E. REID, storekeeper of the Seaboard Air Line at Savannah, Ga., has been transferred in the same capacity to Jacksonville, Fla.

L. H. HAYNES, storekeeper of the Seaboard Air Line at Tampa, Fla., has been transferred in that capacity to Savannah, Ga.

C. A. MARSHALL, stores inspector of the Wabash at St. Louis, Mo., has been appointed division storekeeper of the Central of New Jersey, with headquarters at Elizabethport, N. J.

Robert J. Elliott, director of purchases of the Northern Pacific since September, 1926, retired under the pension regulations of that company. At that time the position of director of purchases was abolished C. C. Kyle, who continued in his present position of purchasing agent, assumed charge of the purchasing and stores department. Mr. Elliott was born at Louisville, Ky., in 1865, entering railway service as a clerk in the accounting department of the Northern Pacific in March, 1892. After serving for a short time on the staff of the general manager Mr. Elliott was promoted to general storekeeper, with headquarters at St. Paul in 1905. Two years later he was advanced to assistant purchasing agent, becoming purchasing agent in 1921. Mr. Elliott had completed 36 years in the service of the Northern Pacific at the time of his retirement.

Robert J. Elliott